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PHOTOENGRAVING IN BLACK AND COLOR

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OR

PHOTOENGRAVING PRIMER

CONCISE INSTRUCTIONS FOR APPRENTICE ENGRAVERS OR FOR THOSE SEEKING SIMPLE YET PRACTICAL KNOWLEDGE OF LINE AND HALFTONE ENGRAVING

BY

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SECOND EDITION

AMERICAN PHOTOGRAPHIC PUBLISHING CO.
BOSTON, MASS.
1938

Printed in the United States of America
by the Plimpton Press·Norwood·Mass.

PHOTOENGRAVING IN BLACK AND COLOR

PREFACE TO FIRST EDITION

Photoengraving is the term used for the engraving of metal plates in relief, with the assistance of photography, so they may be printed together with type. Photoengraving is divided into two kinds. The first is line engraving, in which the subject to be reproduced is in lines or solid areas, such as a pen drawing, a print from a wood engraving, a type page. In fact, anything that has once been printed on a typographic press can be again reproduced by line engraving. A well-printed halftone can, for instance, be reproduced by this process. Besides the rapidity and low cost of photoengraving, its great advantage is that by the aid of the camera, the engraving may be reduced or enlarged from the copy to be reproduced; hence a photographer, experienced in handling the camera, has an advantage in taking up photoengraving.

The second division of photoengraving is called halftone engraving, in which a photograph, painting, water color, wash drawing, or any object possessing gradations of tone, may be photographed through what is termed a halftone screen and its image so broken up into lines or dots that it may be printed on a typographic press.

PREFACE

No changes have been made in the methods used by photoengravers during the past few years. This would indicate that photoengraving has about reached the limit of its development, hence this would seem to be the proper time to record present-day procedure. The fact that many requests have reached the writer for a book giving concise instructions as to just how line and halftone engravings are made, is the reason for the existence of the present Photoengraving Primer.

S.H.H.

Orange, N. J.
1920

FOREWORD A GENERATION LATER

The preface to the first edition was written a generation ago and the chief change in photoengraving since then is the introduction of the color-sensitive emulsion dry plate for color plate making. Instructions for handling dry plates are told briefly in this revision of the original Primer. It might be said here that in the author's opinion, for black and white reproduction, the wet-plate method of negative making still gives sharper lines than a gelatin emulsion plate. One reason for this is that the silver image is as thin as a soap bubble on the surface of the wet collodion. With emulsion on a dry plate, the grains that form the silver image are buried in the gelatin emulsion at different depths and therefore cannot give the sharp-edged line of the wet plate. A proof of this is that photoengravers, who lead and take pride in the excellence of their black and white reproduction, cling tenaciously to collodion and the silver bath, thus retaining their patronage, owing to better results. The most successful photoengravers keep separate their wet-plate, black and white gallery from their dry-plate, color studios.

Louis Flader, who knows more about photoen-

graving history than any man living has this paragraph in an editorial in the *Photo-Engravers Bulletin* for November, 1937: "Photoengraving may be rated as one of the greatest inventions of all times. It superseded handcraft methods in printing platemaking and substituted photographic and mechanical speed, accuracy and precision for the uncertain efforts of human hands. Photoengraving made possible printing as it is known today. Modern printing has made possible the rapid dissemination of news and in turn has substituted new methods of merchandising and distribution for those formerly in existence. No manufacturing nation, group or community can exist unless it can distribute and dispose of the manufactured products. Photoengraving has done more to make modern business what it is than any other single agency."

ORANGE, N. J. S.H.H.
January, 1938

PHOTOENGRAVING IN BLACK AND COLOR

PART I

LINE ENGRAVING

The Studio. — The best studio for photographic copying is out of doors in daylight. As this is not always practical, an indoor studio must be had which will permit as much daylight to enter as possible. The only drawback to daylight is its uncertainty. Therefore, it is now customary to use artificial light in the form of electric arc lamps. A pair of arc lamps of high amperage, or, nitrogen-filled tungsten lamps at least, are recommended, and that they be installed by a competent electrician familiar with the local conditions of electric current, etc.

Camera. — The camera should be one constructed for the purpose of copying pictures. Its special characteristics are its rigidity and a long bellows by which enlargements can be made. The front of the camera is fixed solidly to its base or bed, while the back of the camera, containing the groundglass, moves on grooves that keep it parallel

with the front. The whole camera rests on an iron stand, to one end of which is fixed an upright copyboard. This copyboard, large enough to take the biggest copy, is made of soft pine, so that it may be easy to stick pins or tacks in it. It slides in grooves at top and bottom, so that it can be shifted sideways to center the copy. The front of the camera should slide up and down, to center copy in these directions. It is well to stain the copyboard black.

Vibration of the camera while photographing must be guarded against. This vibration is prevented by springs somewhere in the camera stand, or by suspending the stand with ropes or springs from above. If suspended it will be found that three ropes serve better than four. A test for camera vibration is to place a bottle of some light liquid like ether or benzine on the camera and observe the reflection of light on the surface of the liquid. If waves are seen, there is vibration, and unless the copyboard and the groundglass vibrate in absolute unison, which seldom happens, perfect line negatives cannot be made on such a camera until the vibration is taken up by springs of some kind.

The Lens. — An anastigmat lens, of which there are several good makes, is best for photoengraving, though no lens should be accepted without trial. The equivalent focus of the lens should be equal to the diagonal of the largest negative required to be made in the camera, or the largest

plate to be engraved. The lens must also have a slot for using Waterhouse diaphragms, or stops. A focusing glass is a valuable aid in getting a sharp image on the groundglass.

Artificial Lighting. — Electricity is the best source of artificial light, because it gives in the arc form a whiter light than other sources. The open or flaming arc is most frequently used, though the enclosed arc, that is an arc enclosed in an almost airtight glass globe, is quite satisfactory because of the fact that its light is more violet in color and therefore powerful photographically.

As the electric current varies with locality and the patterns of arc lamps are so numerous, a local electrician should be consulted regarding the installation of artificial light.

The Darkroom. — In providing a darkroom, as it is called, all that is necessary to be considered is that all white or actinic rays of light be excluded. A room could be constructed entirely of amber-colored glass and, providing no ray of white light entered, wet-plate negative making and other photo-engraving processes, except color photography, could be carried on with safety in it, because the collodion wet plates and metal sensitizers used are not sensitive to orange-colored light.

Good ventilation is most important in a darkroom, together with an equable temperature of about 60° F. (15.6° C.), not only for hygienic reasons,

but also to keep the chemical solutions used there in proper working condition. Inlets and outlets for air, that will exclude light, can be readily devised.

A steady flow of clean water is necessary in a darkroom as well as a deep sink from which the water will not splash over the sides.

Darkroom Illumination. — If gas or kerosene light is used for illumination they had better burn outside the darkroom, before a large window glazed with yellow glass in the darkroom wall. This prevents the air in the darkroom from being contaminated. Of course if incandescent electric lamps are used they can be in the darkroom, the only precaution being that the globe be a deep orange or amber, or that it be wrapped in orange paper, or placed in an amber-colored bottle, from which either the top or the bottom has been removed.

For heating the darkroom during cold weather there is nothing better than an electric radiator, or, the rheostat connected with the arc lights could be moved into the darkroom in cold weather.

Darkroom Facilities. — As the darkroom must be free from dust the fewer articles kept in it the better. The silver-bath-holder, in its box at one side on the floor, with a shelf over it on which the plateholder can rest as it leans toward the wall; another shelf or cupboard for the clean glass with a place near to rest the collodion bottles, and a shelf back of the sink for developer bottles, are all

that is required in the darkroom. All chemicals and stock solutions had better be kept in another room near by, where solutions are made up and which might be termed the chemical room.

Chemical Room. — In this room are kept the scales and weights, graduates, funnels and all the vessels necessary for preparing solutions and keeping them in order. It is the general workroom, and in it should be a closet with shelves to hold the stock chemicals in their carefully labelled, corked and covered containers, as so many photographic chemicals spoil when air is admitted to them and sometimes when they are exposed to white light.

Requisites for Negative Making. —

1 glass, wood, or hard-rubber, vertical bath-holder with box and cover;
1 glass, wood, or hard-rubber dipper for bath;
1 gallon (4 liter) glass funnel for silver bath;
2 one-quart (1 liter) glass funnels for collodion;
1 quart (1 liter) hard-rubber funnel for developer;
1 hydrometer (argentometer) for testing silver bath strength;
1 set of scales with apothecaries' and metric weights;
1 gallon (4 liter) evaporating dish for silver bath;
1 16-ounce (500 cc.) glass graduate;
1 8-ounce (250 cc.) glass graduate;
1 4-ounce (100 cc.) glass graduate;
1 tube blue litmus paper for testing silver bath;

2 1-gallon (4 liter) wide-mouthed bottles;
1 15-inch (4 cm.) glass stirring rod;
2 negative racks;
2 collodion bottles;
1 hard-rubber tray for acetic acid stripping solution;
Acid proof tank, or jar, for glass cleaning solution;
Boxes of first quality sheet glass for negatives.

Chemicals for Negative Making. —

2 pounds (1 kilo) silver nitrate;
2 gallons (8 liters) grain (ethyl) alcohol;
16 pounds (8 liters) sulphuric (ethyl) ether;
1 pound (½ kilo) pyroxylin (negative cotton);
1 pound (½ kilo) pyroxylin (soluble cotton);
1 pound (½ kilo) ammonium iodide;
½ pound (250 g.) cadmium bromide;
½ pound (250g.) resublimed iodine;
½ pound (250 g.) potassium iodide;
5 pounds (2½ kilos) copper sulphate;
10 pounds (5 kilos) ferrous sulphate (iron protosulphate);
1 can rubber cement and another of benzine;
5 pounds (2½ kilos) potassium or sodium cyanide;
10 pounds (5 kilos) acetic acid, 1.040 specific gravity;
½ pound (250 g.) castor oil;
1 pound (½ kilo) C. P. nitric acid;
½ pound (250 g.) sodium sulphide.

Negative Collodion. —

Alcohol and ether equal parts;
Pyroxylin, 6 grains (0.39 g.) to each ounce (30 cc.) of combined ether and alcohol;
Ammonium iodide, 5 grains (0.324 g.) to each ounce of above;
Cadmium bromide, 1 grain (0.065 g.) to each ounce of above.

To make, for example, 16 ounces (480 cc.) of collodion by the above formula: 8 ounces (240 cc.) of ether is poured into a 20 ounce (half liter) bottle having a tight cork stopper. Then 96 grains (6.23 g.) of pyroxylin is stuffed through the neck of the bottle and allowed to soak while 8 ounces (240 cc.) of alcohol is measured in the graduate and 80 grains (5.18 g.) of ammonium iodide and 16 grains (1 g.) of cadmium bromide are dissolved in the alcohol by stirring with the glass rod. When these salts are dissolved the alcohol is poured into the ether; then the pyroxylin should dissolve with a slight shaking. The bottle is placed in a cool place for twelve hours or more, so that the sediment may settle, after which the clear collodion is poured off and filtered through a pledget of cotton placed in the neck of a glass funnel. The collodion is then ready for use.

Silver Bath. — The perfect silver bath is simply 45 grains (2.9 g.) of silver nitrate dissolved in

each ounce (30 cc.) of distilled water, made slightly acid with a few drops of chemically pure nitric acid and containing besides a trace of iodine.

If pure distilled water is not at hand, rain water, melted ice, or any other water is put into one of the gallon (4 liter) wide-mouth bottles. Add one ounce (30 g.) silver nitrate and four grains (0.259 g.) potassium iodide to every 16 ounces (480 cc.) of the water. This should make a creamy colored mixture. Stand this bottle in strong sunlight for a day, when it will be found that the organic impurities in the water, have, by the action of light, been precipitated on the bottom of the bottle in a black sediment.

Put a pledget of cotton in the neck of the gallon (4 liter) glass funnel, rest this in the mouth of the second wide-mouthed bottle, carefully pour off the clear silver solution into this funnel and finally shake the black sediment into the filter so that the last drop of silver solution may be saved.

In testing this silver solution with the hydrometer it will be found to register about 30 grains (1.94 g.) to the ounce (30 cc.). Sufficient silver nitrate should be added to make it test 45 grains (2.9 g.) to the ounce (30 cc.). It can then be again filtered, after which chemically pure nitric acid is stirred into it, drop by drop, until blue litmus paper turns slightly red, when a drop of the silver solution is put on it.

This silver nitrate solution is poured into the clean glass bath-holder. A glass plate is coated with collodion, put on the plate dipper and lowered into the silver solution where it is left, for 15 minutes at least, until the silver solution has absorbed the trace of iodine required to put it in perfect working order. The silver bath should be kept clear by frequent filtering.

To Purify an Old Bath. — After much use the silver bath will become contaminated with alcohol, ether and excess of iodides, as shown by pinholes or black specks in the negative, or, by fog all over the plate.

To purify it, pour it into an equal quantity of water; don't pour the water into the bath. This gives a yellow solution. Filter it and pour into the evaporating dish, place it over heat and boil down until it is a yellow pasty mass. When brown fumes come from it, shut off the heat and by stirring with the glass rod break it up into grains like brown sugar. Dissolve this in the amount of distilled water that will make up the quantity of bath you will want. Stand the wide-mouth bottle in the sun until it clears. Filter, strengthen with silver to 45 grains (2.9 g.) to the ounce (30 cc.). See that it is slightly acid, and the bath is then as good as a new one.

It is advisable to always have two silver baths on hand, as foreign matter is liable at any time to

put the bath in use out of order. The second bath should always be in condition to substitute for the first one.

Developer. —

Water	16 ounces	480 cc
Ferrous sulphate ..	1 ounce	30 g.
Acetic acid	1 ounce	30 cc.
Alcohol	1 ounce	30 cc.

Dissolve the ferrous sulphate in the water and add the acetic acid and the alcohol, if the silver bath is an old one. When the bath is new, no alcohol will be required, as the alcohol is used only to assist the smooth flowing of the developer over the collodion film. The developer should be filtered before use and kept cool. A warm developer will cause fog on the negative.

Fixing the Negative. — One ounce (30 g.) of sodium, or, potassium cyanide in 24 ounces (720 cc.) of water is the simple solution used to dissolve from the negative the silver salts unacted on by light, and thus fix the image. Sodium cyanide can be substituted for the potash salt, or sodium hyposulphite (hypo) can be used in a strong solution, though the latter sometimes causes the negative film to crack when dry.

Intensifying. — After fixing and thorough washing, the negative is flowed over many times with the following copper solution, until it turns a creamy white right through to the glass support.

Water, pure or distilled	20 ounces	600 cc.
Copper sulphate	2 ounces	60 g.
Potassium bromide	1 ounce	30 g.

After washing, this creamy white film is flowed once with ½ ounce (15 g.) of silver nitrate to 10 ounces (300 cc.) of water, made slightly acid with a few drops of nitric acid. This will change the color of the negative to an intense brown-black. If it is not sufficiently opaque, the treatment with copper and silver solution can be repeated, washing well after each treatment. An intense blackness may now be given to the negative by flowing it with a solution of sodium sulphide, one ounce (30 g.) in twenty ounces (600 cc.) of water. The intensified negative is then put in a rack to dry.

NEGATIVE MAKING

Cleaning and Albumenizing the Glass. — Having described the various solutions and their uses, we will now proceed to negative making. Glass used for negative making must be absolutely clean. Two parts of nitric acid in ten parts of water, kept in an acid-proof stone-ware vessel, dissolves the foreign matter on glass. The glass can be left in the acid over night, and next morning, as each sheet is removed from the acid, it is laid on a board in the sink and scrubbed with a stiff brush on both sides, and particularly on the edges. While still

wet it is flowed on one side with the following substratum:

Albumen Substratum. — The albumen of a single fresh egg is beaten up thoroughly and mixed with 40 ounces (1.2 liters) of distilled water. Then $\frac{1}{8}$ ounce (3.7 cc.) of ammonia is added and the whole carefully filtered.

When one side of a glass plate has been flowed twice with this albumen substratum the plate is put in a negative rack in a place free from dust to dry. This albumen substratum prevents the wet collodion film from leaving the glass during the different operations. When the albumen coating is dry on the glass, the latter should be stored in a closet or shelf in the darkroom protected from dust.

Coating Glass with Collodion. — To secure a collodion film of even thickness on the glass some practice is necessary. The glass plate is held in the left hand, albumen side up, between the thumb, on the upper side of a corner, with the fingers supporting it underneath. The collodion is poured on the almost level glass near the corner farthest from the fingers holding it. The collodion is allowed to flow toward the upper opposite corner, thence to the lower corner near the thumb, and thence back into the collodion bottle, thus covering the glass completely.

As soon as the collodion begins to flow from the

glass the latter is held nearly vertical and rocked from side to side, so that no ridges will be formed in the collodion film. This rocking motion is continued until the film is set; that is, when enough ether has evaporated so that the film is no longer found to be in solution when touched with the end of the finger at the lower right-hand corner. It is now ready for sensitizing.

Sensitizing the Collodion Film. — The dipper is raised so that the lower part rests on the edge of the silver bath, the collodionized plate is laid upon the dipper face up, and the glass is then lowered into the silver solution without stopping until it is totally immersed. It can be moved about sideways for a few seconds to hasten the action of the silver bath. It is then allowed to remain in the covered silver bath for two or three minutes.

The collodion is now sensitive to the slightest ray of white light, consequently it must be protected from all light other than orange or red until after the image is developed. After two minutes the sensitized plate is slowly withdrawn from the silver solution. It will be found to be a light yellow in color. If oily looking streaks appear on its surface, it must be returned to the bath and left until they disappear. Then it is again slowly raised from the silver solution, taken by the thumb and forefinger and lifted from the dipper. Its lower edge is allowed to rest on a clean piece of blotter, while its

upper edge and back are wiped clean of silver solution with tissue paper. It is then laid in the plateholder, face in, and the back of the plateholder closed, when it is ready for exposure in the camera.

Centering Copy. — It is a good plan to draw pencil lines on the groundglass connecting diagonally opposite corners. Where these lines cross will be the center of the groundglass. When the copyboard is in focus on the groundglass, if an assistant will move the point of a pencil over the copyboard until it appears on the groundglass exactly where these diagonal lines cross, and will mark that point on the copyboard, its center will be found. Diagonal lines drawn on the copyboard, crossing at its center, can be used afterwards as a guide in attaching copy to the board so that its image will be centered on the groundglass.

Focusing. — The size of the copy when photographed is regulated by its distance from the lens, while the sharpness of the image on the groundglass is governed by the distance of the groundglass from the lens. The nearer the lens is to the copy, the larger will be the image of the copy on the groundglass and vice versa. As the camera and lens are drawn away from the copy the image on the groundglass diminishes in size. To focus the image to the size wanted, one pushes the camera to and from the copy, keeping the image in focus by moving the groundglass, until by measurement on the ground-

glass with rule or compass the exact size is secured.

Focusing should be done with a large diaphragm in the lens, and on a point midway between the center and edge of the copy, so that when a smaller diaphragm is used in photographing, the whole image will be sharp.

Illuminating the Copy. — If electric arc lamps are used, one on each side of the copyboard, they must be placed at such a distance from the copy as to illuminate it evenly and at the same time allow no ray of light to strike the front surface of the lens. Whether daylight or artificial light is used, it is an advantage to lay a large plate-glass mirror horizontally on the table of the camera-stand immediately in front of the copyboard, to reflect light from below on the copy.

Exposure. — After focusing to correct size, the camera is secured so that it cannot be jarred out of focus during the exposure of a plate. The proper diaphragm is inserted in the lens, the front lens capped, the groundglass removed, and the plateholder inserted carefully so as not to stir up any dust within the camera. The slide is slowly withdrawn, and, as a precaution against stray light entering the plateholder, it is customary to cover it with the dark focusing cloth. The electric lights are turned on, the cap on the lens removed and the exposure accurately timed to the second. Then the

lens is recapped, the lights extinguished, the slide returned to the plateholder and the latter carried into the darkroom.

Development. — All white light being excluded from the darkroom, the exposed wet plate is taken from the plateholder, held at the corner as when coating with collodion and while perfectly level the developer is poured gently but quickly over the exposed plate and made to spread evenly, without stopping until the whole is covered. Then the plate should be rocked slowly so that the developer may flow backward and forward without allowing any of it to run off the plate. The ability to perform this feat can be acquired. The reason for retaining the developer on the plate is that the free silver on the exposed plate combines with the developer to give intensity to the image. If the silver is washed from the plate by the developer, the intensity of the image will be greatly lessened. When the image stands out boldly, development is complete, and the action is stopped by flooding the plate with water. Washing with running water should be continued for a couple of minutes until all of the free iron is removed, or the negative is liable to be stained in later operations.

The negative is now " cleared " or fixed in the cyanide or " hypo " solution previously described, washed and intensified as previously instructed under " Intensifying."

The Rubber Film. — When the negative is perfectly dry and cool it is coated with a solution of rubber in benzine or benzol. This rubber solution may be made from rubber cement thinned down with benzine, or, ½ ounce (15 g.) pure Para rubber, cut into shreds, can be dissolved over night in 16 ounces (480 cc.) benzine. This should be filtered before use. About the consistency of collodion, it is flowed over the negative in the same manner as collodion is. It dries quickly, leaving a thin film which prevents the collodion which follows from dissolving the collodion of the negative.

Stripping Collodion. — Equal parts of ether and alcohol are measured out, as in making negative collodion. Six grains (4 g.) of pyroxylin (soluble cotton) to the ounce (30 cc.) is first soaked in ether, then the alcohol is poured in, to dissolve the pyroxylin. 1½ to 3 minims (0.1 cc. to 0.2 cc.) of castor oil is added. This collodion is filtered and poured over the rubber film on the negative just as the negative collodion was. It can be dried over heat. Celluloid varnish may be substituted for this collodion.

Stripping and Turning Negatives. — The negative film is now cut all around the image with a sharp knife, after which it is laid in a tray containing acetic acid solution in the proportion of 1 ounce (30 cc.) acetic acid to 10 ounces (300 cc.) of water. This solution penetrates more quickly

when warm. In from three to five minutes it will have soaked through the film, destroyed the albumen substratum which held the original collodion film to the glass, and permit the negative to be stripped from the glass.

This is done by first washing the negative free from acid, then removing the outside strips of negative film, that are not wanted, from around the negative image, then laying the negative on a level support and flowing it with clean water. Now, with the sharp point of a knife, a corner of the negative is raised from the glass and the whole negative turned back until it is stripped and laid upper-side down on another sheet of glass. Such a glass, when it has several negatives laid side by side, is called a " flat."

PHOTO–PRINTING ON METAL

Printing Requisites. —

A printing frame to take the largest metal plate required;
A wide, fine-haired powdering brush;
A smooth skin lithographic roller;
Asphalt and shellac varnish with assorted brushes;
Etching ink, ink slab and ink knife;
Wide-mouth pliers;
16 ounce (500 cc.) glass graduate;
Magnifying glass, sold as " linen tester ";

Quart (1 liter) glass funnel;
Large, soft chamois skin;
1 pound (½ kilo) of ammonium bichromate;
Hard-rubber tray for developing the image on metal;
Gas or kerosene stove;
Polished zinc, 16 gauge (1.7 mm.) or 14 gauge (2.1 mm.) in thickness;
Caustic potash, aqua ammonia and turpentine;
Charcoal and powdered pumice stone for polishing.

The Printing Darkroom. — The room in which the photo-printing on metal is carried on should also be a darkroom, illuminated with yellow light, though sensitized metal plates are not very sensitive to light. Cleanliness and freedom from dust are also essential here. A low table or bench is required, to hold the heavy printing frame, and another low bench for the ink slab, with bench space alongside to roll the exposed metal plates with ink. A clean gas or kerosene stove is needed to dry the albumen film, which makes the metal sensitive to light. A wide sink, with a tap of running water over it, is important, as well as a hard-rubber or other tray in which the inked metal plate can be developed.

Polishing Zinc. — Zinc sheets, 16 gauge (1.7 mm.) or 14 gauge (2.1 mm.), in thickness, are usually purchased ready polished. The sur-

face will be found to be greasy and oxidized, so that a fresh surface of clean zinc must be produced. To do this, a wide board is set on an incline in the sink, with a strip of zinc secured across it near the bottom. On this board the zinc plate is laid, with its lower edge against the zinc strip, and kept wet while it is rubbed with wet powdered pumice or the end of a polishing charcoal. The direction of the rubbing should be the same as that of the original polishing. The powdered pumice is rubbed on with a felt pad. This polishing should be continued until the original polish of the metal is completely ground off and the surface of the plate takes the water readily. Polishing charcoal had better be kept in water when not in use.

Should the zinc be unpolished, then the smoother side is chosen and the scale on the surface removed either with Scotch hone or a block of pumice stone. These will leave fine scratches that can be removed either with charcoal or powdered pumice in the final polishing. After polishing the surface of the zinc, it is washed with a pad of cotton in running water, to remove any scum that might adhere to its surface. The polished zinc can be kept under water to prevent oxidization. The sensitizing of the metal should take place as soon after polishing as possible.

ZINC GRAINING SOLUTION

Zinc sheets must be freed from the grease left on them from polishing. Treatment with caustic soda does this, as told in the preparation of copper later. Zinc should then receive a fine matt surface to better hold the albumen or enamel sensitizing coating. The graining solution is: 30 ozs. water, ¼ oz. nitric acid and 3 ozs. of common alum, powdered. This is used in a tray and brushed over the zinc until a beautiful matt surface appears, when it is removed quickly to running water to wash away the acid. It is ready for flowing with the sensitizer immediately.

Sensitizing Solution for Zinc. —

Water, distilled	8 ounces	240 cc.
Albumen of fresh egg	1 ounce	30 cc.
Ammonium bichromate	20 grains	1.3 g.
Aqua ammonia	8 drops	8 drops

The albumen of a fresh egg is beaten to a froth and permitted to settle. Four ounces (120 cc.) of the distilled water is stirred into the albumen and the ammonium bichromate is dissolved in the other four ounces (120 cc.) of water. While the albumen and water solution is briskly stirred with a glass rod, the bichromate and water solution is slowly poured into it, and then the ammonia added from a dropping tube until the whole turns to a pale straw color. This solution must be carefully filtered be-

fore use. It is better made up fresh each day and kept on ice to prevent decomposition.

Sensitizing the Zinc. — In the printing darkroom, which must be as free from dust as possible, the freshly polished zinc plate is rinsed in clean water, drained and flowed with the bichromate solution. The first coating of the solution is allowed to drain off into the sink, to remove the water from the surface. Again it is flowed with the solution, taking care that no air bubbles are formed on the surface. When an even coating is secured, the plate is held at an incline over the heat so that the upper edge of the plate may dry while the solution on the lower portion is draining off. A better method is to spin it on a whirler. Keep the plate moving, being careful not to heat the zinc at any place warmer than the back of the hand will bear, otherwise the film of albumen may be coagulated, so as to be worthless.

When the albumen film begins to dry at the upper edge, drying can be hastened, and the surface of the plate kept cool, by gently blowing with the breath until the whole is dry. The sensitized zinc is then stood on edge, face to the wall, to cool, while the negative and frame are prepared for printing.

Photo-Printing on Zinc. — The thick plate glass in the printing frame is wiped clean. The negative, or flat, is laid over the sensitized zinc plate, face to face, and both are inverted without

permitting the negative to slide on the delicate albumen surface of the zinc and thus scratch it. The negative is laid in the printing frame, the back of the zinc plate uppermost. The felt or soft blanket is placed on top of it, the back of the printing frame inserted, and pressure applied, in locking up the frame, sufficient to bring the zinc in absolute contact with the negative without breaking the glass in the frame.

Exposure to Light. — The proper time required to expose a sensitized zinc plate to light depends on many factors: the clearness of the lines in the negative; the time of year; the time of day; whether bright sunlight or cloudy weather; if electric light is used, the strength of the light; the distance of the printing frame from the light, etc. The proper time must be found by experiment. In clear sunlight it should not be more than a minute, while with electric light or on a cloudy day, it might be five to ten minutes. Care should be taken when using the electric light that the glass of the frame does not get too hot or it may coagulate the albumen film on the zinc.

Inking the Exposed Zinc. — The ink and roller must be made ready beforehand. This is done by taking a small piece of etching ink on the end of the ink knife and spreading it across the ink slab. If the ink is too thick, it can be softened with a few drops of turpentine, linseed oil varnish,

or oil of lavender. The stiffer the etching ink when used, the better. Heating the ink, or the slab, is frequently sufficient to soften the ink. Brisk and continued rolling will give the required even coating of ink on the slab. When this is accomplished, the exposed zinc plate, slightly warm, is laid on a flat board and rolled, over and over again, until it gets a slight film of ink over its whole surface. As etching ink has a little lamp black in it, the ink film should not be put on so thick that the zinc cannot be seen faintly through it. Of course this inking of the plate is performed in the darkroom. Gas or incandescent electric light has not sufficient strength to affect the sensitive zinc plate.

Developing the Image on Zinc. — This is the most interesting operation in the whole process, for it is always pleasing to see an image in ink appear as if by magic on the zinc. The inked zinc is laid in a tray of clean water for a minute, no air bubbles being permitted to remain on its surface. Then a wad of wet cotton is drawn softly over the inked surface while it is under water. It will be found that the albumen coating, where it is not hardened by the action of light, comes away readily from the zinc, carrying with it the overlying coat of ink, while the albumen that has been hardened by the action of light will adhere firmly to the zinc, together with its covering of etching ink. The gentle rubbing with wet cotton, while the plate is sub-

merged in the water, is continued until the whole image is cleared of ink between its lines and dots. Should the inked lines break away from the zinc, the exposure to light has not been long enough, or the lines in the negative have been filled up, while if the ink refuses to leave the plate between the lines or dots, the exposure has been too long or the negative is not opaque enough.

Re-exposure of the Zinc to Light. — Should the image on the zinc be unsatisfactory, through over- or underexposure or for any other reason, another print can be made on the zinc after removing the first image. The re-preparation of the zinc must be done thoroughly, or the first image will remain and interfere with the second one. The ink on the zinc must first be gotten rid of with a strong solution of caustic potash and a scrubbing brush. The hardened albumen image still remains, though invisible, and can only be removed by polishing the zinc, as at first, with charcoal or powdered pumice on the felt pad. When a fresh and clean surface of zinc is once more obtained, the zinc can be sensitized with a bichromatized albumen solution, as previously described.

Retouching the Inked Image on Zinc. — When a satisfactory print in etching ink is developed on the zinc, this is washed in running water and dried. Be careful not to heat the zinc too hot, while any drops of water remain on it, for these may melt

the grease in the ink and spread it over the plate. It is better to absorb the drops of water on the zinc with a soft wet chamois skin, made into a pad, or with lintless blotting paper.

After the zinc is dry, the ink image on it is carefully examined for any breaks in the lines, or holes in the ink covering. The broken lines can be connected, bare spots in the zinc covered, and missing dots added, with a retouching ink made either with asphalt varnish or by diluting a little of the etching ink with oil of lavender or turpentine. The retouching should be done with fine brushes. Lettering, border lines, figures, or additional drawing of any kind can be added to the image on zinc at this time with brushes or pens and retouching ink.

Protecting the Inked Image with Resin. — After retouching the inked image on the zinc it is ready to be protected from the action of acid with powdered resin. Any true resin, such as common rosin, copal, shellac, or powdered asphalt, if ground to a flour, will answer admirably, although it has been found in practice that the resin called dragon's blood is the most suitable. This is a red substance which can be purchased in powdered form. It is best kept in a shallow metal box, covered, so as not to become too dry. This box, preferably, should be wider each way than the largest zinc plate to be etched. Plenty of sifted dragon's blood powder is kept on the bottom of this box.

Ink and Resin a Perfect Acid Resist. — The warmed zinc plate is pushed under the resin powder on the bottom of this box, and every portion of the ink image on its surface covered with the resin. It is then raised up and one edge is struck against the bottom of the box to jar off the surplus powder not adhering to the greasy ink. It is then rested on one side of the box while a broad, soft-haired brush, kept for the purpose, is used to sweep the surface clean of the resin, brushing the powder back into the box. If no brush is at hand, the plate could be brushed clean with a large pad of dry cotton. The finest inked lines will hold the resin powder and the object of this brushing is to remove every grain of resin from the bare zinc. To tell when this is accomplished, hold the zinc plate level with the eyes before a strong light and look over its surface, when any resin powder resting on the bare zinc can be seen and removed.

Incorporating the Resin with the Ink. — The zinc plate is now gripped firmly at one edge with the wide-mouth pliers and held over a stove, moving it so that every part will be heated alike. Soon the ink will begin to soften and absorb the red resin powder. The ink will first become dull in color and then turn glossy, when the heating should be stopped. The ink must be softened only enough so that the resin can be incorporated with it, but the plate is not permitted to get so hot that

the ink will melt and spread over the zinc. When the ink over every portion of the plate has become so heated that all the dragon's blood is taken up by it, the back of the zinc is painted over with asphalt varnish. This is also painted on the face of the plate around the image, as well as on all the broad spaces between the lines that are to remain white when the plate is printed from.

The First Etching. — The zinc is now ready for the important first etching. As the success or failure of the engraving depends on this, instructions for it will be given in detail. Two ounces (60 cc.) of 40° Baumé nitric acid, diluted with 60 ounces (1.8 liters) of water, will be a safe proportion for a first etching bath. Enough of this solution to cover the plate well is put in the etching bath holder or " tub " as it is called. The surface of the zinc plate to be etched is well wetted under the tap, and it is then laid on the bottom of the etching tub while the latter is rocked so that the acid solution will flow back and forth over the zinc.

Fine bubbles of hydrogen gas will soon form on the zinc. These must be removed with a flat soft-haired brush while the rocking of the tub is continued. This rocking, by keeping the acid solution in motion, prevents the adhesion of these gas bubbles to the plate, and at the same time washes away any sediment formed by the acid as it dissolves the zinc. The action of the solution back and forth

over the plate is not sufficient to keep the etching surface of the zinc free from zinc oxide, so a flat bristle brush is used at intervals to clear off the oxide and keep the metal bright, without stopping the rocking of the tub.

When to Stop the First Etching. — It is an advantage to lift the zinc plate from the acid bath occasionally, and turn it so that the acid may flow over it in a different direction. After two minutes, the finest lines or dots on the plate must be watched. The moment there is an indication that the etching solution is corroding the sides of the finest lines or dots, the zinc must be taken out of the bath and plunged quickly into a bath of clean water or under running water, to instantly stop the action of the acid.

To Determine the Proper Depth. — The finest etched lines and dots are now examined with a powerful magnifier in a strong light. It will be observed that the zinc surface between the lines has been dissolved away, showing bright at the edges of the lines and dots. Retouching of weak lines and dots can now be done with a fine brush. If the finest lines or dots show no signs of breaking, the zinc plate can be again wetted with water and put back in the acid solution, and the rocking of the tub continued. But from this time the fine lines must be watched intently, for a dot or a line once etched away cannot be restored. The depth of this first

etching, or " bite " as it is called, is usually the thickness of a visiting card. It is determined by feeling with the thumb nail against the side of an etched margin. If the thumb nail catches, the depth is sufficient to hold the resin powder in the following operations.

The First Powdering with Resin. — On the first etching, and the care with which the first powdering is done, depends the success of the finished engraving. After the zinc plate is taken from the etching bath and quickly washed, front and back, with clean water, all excess water is absorbed from it with a damp chamois skin. It is then dried over the heat and cooled. The plate is now marked so as to indicate the top, bottom, right and left sides for the " four-way powdering " which follows.

While the zinc plate is just warm enough to be comfortably held in the hand, the top is pushed under the dragon's blood powder in the box. The plate is lifted, top side uppermost, and the resin powder thus taken up is allowed to slide over the face of the plate from top to bottom into the powder box. The plate is then held at an incline, with the bottom resting on the edge of the box, while a flat fine-haired brush, held vertically, is swept across the plate from top to bottom only, so that the resin powder is swept against the upper side of the lines and off the plate into the powder box. It is important that the bare surface of the zinc be swept clean

of any grains of powder. This can be told by holding the zinc plate up level with the eyes in a strong light, and looking across it as before described. It will be observed that the red resin powder has been pressed against the upper side of the lines while the lower sides of the lines are free from resin.

The plate is now gripped with the wide-mouth pliers and kept horizontal without jarring, which would throw down the resin banked against the upper side of the lines, while it is moved over the heat until the zinc is just hot enough to melt the resin powder and cause it to stick to the upper side of the lines and dots.

Powdering Four Ways. — When the plate is cool again, so that it can be held in the hands, this operation is repeated, only this time the bottom edge of the zinc plate is pushed under the pile of resin powder in the box. The resin is permitted to slide from the bottom of the plate toward the top, and is then pushed against the lower side of the lines and dots by the brush. All the operations are repeated exactly as instructed for the first powdering, except that this time the effort must be to bank the resin powder against the lower side of all the lines and dots on the plate.

When the bare zinc is swept clean of powder, the plate is again gripped by the pliers, without jarring, and the resin attached by heat to the lower sides of all the lines and dots on the plate. At this stage it

will be apparent that, when the plate is held with the top uppermost all the horizontal lines on the plate, that is those crossing from right to left, are now protected on both sides from action by the acid. It now remains to protect the vertical lines on both sides in the same manner. This is done by repeating the operations already described, seeing that first the right side and then the left side of the vertical lines are protected, after which the plate is ready for the second etching.

The Second Etching. — The acid solution in the etching tub is made stronger by the addition of about 1 ounce (30 cc.) more of nitric acid, well stirred in. The zinc plate is wetted under the tap, laid on the bottom of the etching tub, and the flowing of the acid solution back and forth over the zinc surface begins. If the bare zinc has not been swept clean from the resin powder in the operations of powdering four ways, it will now show itself as a grain between the lines. This can sometimes be removed by brushing with a bristle brush while the plate is etching. When this grain is too strong to be removed in this manner, the plate is taken from the bath, washed, and the resin powder between the lines removed with a sharp steel scraper. After this, the zinc is returned to the acid and the brushing continued, so that the bare zinc between the lines shall be as smooth as possible, so as not to hold the resin in the next powdering. This second etching

is continued from three to five minutes, or until there is an indication that the finest lines or dots are in danger of being undercut. Undercutting occurs when the etching solution corrodes the zinc underneath the dragon's blood protection. At the appearance of undercutting the plate must be taken from the etching bath and quickly washed to stop the acid action.

The Third Etching. — After washing the plate and absorbing the moisture, as before, with the damp chamois skin, the plate is dried and examined to see if it requires any retouching. While slightly warm it is brushed with the resin powder in four directions and heated, precisely as instructed for the four-way powdering prior to the second etching, care being taken again that the powder is swept clean from between the lines. Another ounce (30 cc.) of nitric acid is added to the etching bath, the bath rocked, and the plate brushed as before, except that now the plate can be brushed more vigorously without danger of injuring the engraving. It is always well to turn the plate at intervals, so that the action of the acid against the sides of the lines will be uniform. The period of this etching can be about ten minutes. After five minutes the plate should be taken out, quickly washed, and examined with a magnifier in a strong light, to see that the protection is not breaking away from the engraving at any point. If it does show signs of

breaking away, the plate can be dried and the weak point strengthened by painting on some of the retouching ink.

Re-inking the Etched Plate. — As a further protection for the surface of the engraving against the action of the acid, the plate, while warm, is sometimes rolled with a soft etching ink. This is the regular etching ink softened with tallow, linseed oil varnish, palm oil, oil of lavender, or any oil. It can be done after the second or third etching. This soft ink will take up a quantity of resin powder when it is brushed over it. After all the surplus powder is cleaned away from between the lines, the plate is heated until the resin just begins to melt and flow down the sides of the lines, and then cooled. Whether re-inking of the plate is done after the second or third etching, or is required at all, depends on the character of the work being etched. If a wood engraving is being reproduced, where the lines are close together, then the etched depth between the lines need not be great and this re-inking may be omitted. It is only with coarse subjects, such as plans and maps, or where the etching must be extra deep, that re-inking is necessary.

When a Fourth Etching Is Used. — It is only for a very deep engraving that a fourth etching is used. Daily newspaper engraving, where stereotyping is done, requires deeply etched plates. For a fourth etching, the plate is powdered four ways as

for the second and third etchings. Some etchers remove all the resist on the plate and re-ink it heavily with soft ink, powder it fully, heat it well, and then put it in the etching bath to etch away the shoulders, or ledges, that sometimes form on the sides of the lines, thus getting a sharper plate for stereotyping or printing on soft paper. Much depends on the purity of the zinc being etched. Zinc that is purchased, polished for engravers' use, is selected for that purpose, and will etch deeper with less trouble than common sheet zinc, and should not require a fourth etching.

In zinc etching the corrosive action generates so much heat that during the summer, or in warm climates, it is advisable to keep lumps of ice in the nitric acid bath to prevent it from getting so hot as to soften the ink and resin etching resist and permit the acid to get through.

Clearing the Resist from the Plate. — To clear away the combination of ink and resin that has protected the plate from the acid during the etching, it is necessary to hold the plate, with the wide-mouth pliers, over the heat until it is sizzling hot, lay it on a board in the bottom of the sink, pour over it strong caustic potash or lye solution, and scrub it front and back with a stiff brush. The moment all the resist is loosened from it, turn on the water to prevent corrosion by the potash. When the potash is washed away, and while the plate is still

wet, pour over it a saturated solution of copper sulphate. This will stain the zinc black. The printing surface of the zinc is then polished off with the side of a block of charcoal, when the bright lines will stand out in strong relief against the black background, so that the quality of the engraving can be judged. Lines that were thickened in places by retouching can be corrected with the graver. The brightness of the lines will guide the router when the spaces between the lines are deepened by the machine.

Deepening Spaces Between the Lines. — To get rid of the zinc between the lines and so lower these spaces, that when printing the ink rollers will not reach them, nor the paper touch them, it is customary to use a routing machine. Where a routing machine is not available, the zinc plate is nailed to a board, and small chisels or gouges are used to cut away the metal which is not wanted. A jig saw will remove all the useless zinc around the edges.

Another way to deepen the white spaces is to paint with asphalt varnish over the printing surfaces and permit the zinc spaces to be etched away in the etching tub, guarding against undercutting.

Fastening the Zinc Engraving to the Wood Block. — This operation need not be described at length, as it is only necessary to nail the zinc plate with blocking nails on a wood block that

will bring the surface of the engraving to the proper printing height, or type high. A sharp steel punch is first used to punch holes in the zinc, and after the blocking nails are hammered into these holes they are driven home with a nail punch.

PHOTOENGRAVERS' MACHINERY

The writer was in business in New York as a photoengraver in 1881. I was obliged to buy zinc in ingots from the New Jersey Zinc Co. and send it to a mill to be rolled into sheets. The only tool to cut the sheets was a zinc hook. A router, crude as it was, had to be made to order. When etching, I would pour etching solution from a pitcher on the zinc to deep-etch an area in the metal. Later I wrote to Anthony's Photographic Bulletin for an inventor to devise an etching machine showing a plan for raining acid mordant on the zinc while the latter was rocked. About a year later Louis E. Levy patented his first etching machine. During the next few years fifteen etching machines were on the market.

In June 1910 while attending the Photoengravers' Convention I saw two etching machines, one etching newspaper halftones in forty-five seconds and the other etching copper halftones in ninety seconds. I endorsed the machines enthusiastically and introduced in this country the idea of throwing the etch-

ing fluid in drops and with force at the metal thus etching deeply and quickly. This proved the value of machinery in photoengraving and stimulated inventors to speed up other parts of the work.

At the forty-first Photoengravers' Convention in 1937, one could witness how important machinery has become: the high-ampered arc lights and the improved carbons for them: the sturdy, non-vibrating cameras: Fruwith Focusing Scales: Douthitt Diaphram Control Scales: immensely improved lenses and prisms: copper and sheet zinc sheets, polished to mirror perfection: compounded chemical solutions. Etching machines are plentiful, with electric etching a competitor. John Royle and Sons showed perfection in routers, saws, trimmers and other machines with micrometer measurements connected with all of them. Then there were precision proof presses, even to one for proofing a set of four-color plates almost while you wait.

PART II

HALFTONE ENGRAVING

The Halftone Screen. — The essential additional requisite for a line-engraver, who desires to make halftones, is a halftone screen. This is composed of two sheets of thin plate-glass, ruled with diagonal black lines, secured together face to face, so that the lines cross each other at right angles, thus producing transparent square openings. The width of the openings is usually equal to the width of the lines. Max Levy & Co. of Philadelphia makes these screens.

The standard rulings, or pitch, for these screens are: 40, 50, 55, 60, 65, 80, 85, 100, 110, 120, 133, 150, 175 and 200 lines to the inch, or 16, 20, 22, 24, 26, 30, 34, 40, 44, 48, 53, 60, 70 and 80 to the centimeter. For newspaper printing from stereotype plates, screens with 65 lines to the inch (26 per cm.) are used; for weekly newspapers printing direct from the halftones, those with 85 and 100 lines (34 and 40 per cm.); for calendered paper, those with 120 lines (48 per cm.); and for coated paper, with fine ink and printing, those with 133 and 150 lines (53 and 60 per cm.) are customary. So the

reader can select the screens he requires, according to the purpose for which the halftones he intends to make are to be used. Many engravers carry on business with only screens of 65, 100, and 133 lines to the inch (26, 40, and 53 per cm.).

The standard sizes of the halftone screens are: 6 x 8, 7 x 9, 8 x 10, 9 x 11, 10 x 12, 11 x 14, 12 x 15, 13 x 16, 14 x 17, 15 x 18, 16 x 20 inches, and larger, up to 32 x 40 inches. These are, in metric measurements: 15½ x 20, 16½ x 21½, 18 x 23, 20½ x 25½, 23 x 28, 25½ x 30½, 28 x 35½, 30 x 40½, 35½ x 43, 38 x 45½, 40 x 50, and 40½ x 51 cm. The screens are usually cut ½ inch (12 mm.) larger each way than the above dimensions.

The Halftone Plateholder. — The early makers of halftone negatives used the halftone screen in the ordinary wet-plate holder. The separation between the halftone screen and the sensitive wet plate was secured by strips of cardboard laid between the corners of the halftone screen and the sensitive plate, the focusing groundglass being set back from its customary position by a depth equal to the thickness of the halftone screen and the cardboard separation. This separation was usually the same for all reductions, and the required variations in the halftone dots were obtained by the use of diaphragms with different-sized apertures. When one has only an occasional halftone to make, this method can be adopted.

A Halftone Plateholder an Economy. — It is more economical to begin with a regular halftone plateholder, with its accompanying groundglass, to fit the camera used for making line plates. There are several designs of these plateholders, with devices for moving the halftone screen back and forth from the sensitive plate, at the same time maintaining perfect parallelism between them. A pointer and scale on the outside of the plateholder shows the separation between the screen and the sensitive plate.

The best patterns of halftone cameras have an ingenious mechanism for holding the halftone screen in the back of the camera, the plateholder carrying only the sensitive plate. A lever at the side of the camera moves the halftone screen forward when the groundglass is being used for focusing. After the plateholder with its sensitive plate is brought into its place at the back of the camera, a simple movement of the lever brings the screen back to any required distance from the sensitive plate, the separation being accurately shown by a scale and pointer beside the lever.

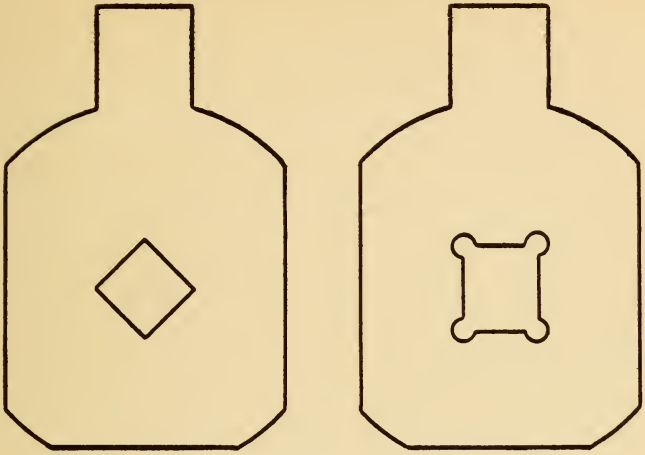
This pattern of camera may cost more but it quickly pays for itself in the saving of time and in the certainty of better quality in the negatives produced by it. With such a camera the halftone screen is not liable to be stained with silver nitrate, or broken, while being carried back and forth in

the plateholder. When the screen is removed from its place in the back of the camera, ordinary line negatives can be made with this camera.

Additional Requisites for Copper Halftones. —

Deep hard-rubber etching tray to take largest copper plate;
Flat camel's hair etching brush;
A dozen Chinese marking brushes, assorted sizes;
A dozen sticks lithographic crayon (Korn's);
Blotting paper;
Clarified fish glue;
Iron (ferric) chloride, either lump or in solution;
Blocks of magnesium carbonate;
Aniline dye, water-soluble (methyl violet);
Wood (methyl) alcohol;
Baumé hydrometer, 0° to 70°;
Whirler for evenly coating metal with enamel;
Nail brush for removing "scum" and enamel fringe;
Douthitt Diaphragm Control System with instructions, which should be studied closely.

The Lens and Diaphragms. — The same lens which is used in making line negatives is suitable for halftone negative-making. It should have a slot for the insertion of diaphragms or stops, other



Shadow Stop Highlight Stop

"HORGAN STOPS"

For getting contrasty halftones for newspapers.

than the round stops supplied by the iris diaphragm system usually found in modern lenses.

If it is remembered that each halftone dot in the negative is practically an image of the aperture in the diaphragm or stop used in the lens, then the reason for other apertures than round ones can be understood. A square opening will tend to produce square dots in the negative, a diagonal slot in the stop will give diagonal shaped dots, and so on.

Horgan Stops. — The writer has used this principle to secure the great constrasts in the halftone negatives which are so valuable in newspaper

printing. A large square stop with corners extended was used to quickly connect up the highlight dots in the negative, while a small square stop, placed diamond fashion, prevented the connection of dots in the shadows. These stops came into general use on newspapers for the purpose intended and were given the name of "Horgan stops." Where the copy is perfect, and it is required to make an exact reproduction of it, without exaggeration of either lights or shadows, it is better to use round stops.

Stops of any size with apertures of any shape can be cut out of cardboard and stained black with India ink, particularly at the edge of the aperture.

Halftone Collodion. — Halftone collodion differs from line collodion only in a slight increase in the bromide used, so that the same formula as that given for line collodion will answer with the addition of one grain (.65 g.) of cadmium bromide. See to it that the alcohol is genuine 95 per cent grain (ethyl) alcohol, and the ether sulphuric (ethyl) ether with a specific gravity of .720. The writer prefers ammonium iodide crystals that are not white, but of the color of light-brown sugar. Collodion made with them ripens more quickly, that is, it can be used almost as soon as made. Collodion grows darker in color with age and works more slowly. It might be added that cadmium acts as a preservative in collodion.

In halftone negative-making it is better to keep

the silver bath at a strength of 45 grains (2.9 g.) to the ounce (30 cc.) of water.

Studying the Screen Distance. — The effect on the sensitive plate of varying the distance of the halftone screen from it, and the differences that changes in diaphragms make, should be thoroughly studied and certain principles learned, before the making of a halftone negative is attempted.

For this purpose the groundglass should be perfectly flat, so as to be absolutely parallel with the plateglass halftone screen. Even though the grain of the groundglass may be as fine as it is possible to get, the dot variation can be more easily studied through a transparent streak drawn from the center of the groundglass to a corner by rubbing with vaseline or oil. A powerful magnifying glass is necessary, not only for use here, but for studying the halftone dot formation in the negative later.

Choosing the Highlight Stop. — The first thing to bear in mind is that the normal stop to use is one that will give a sharp image of the object without the halftone screen intervening. Insert this stop and focus on a sheet of white paper covering the copyboard. Bring the screen close to the groundglass, when the cross lines on the screen will throw on the groundglass sharp shadows surrounding square light spots. Slowly move the screen away from the groundglass, while studying the effect with the magnifier. The screen shadows will

become less sharp until the cross bars disappear, and in place of squares of light, dark squares are seen. By careful adjustment of the screen distance, a chess-board pattern will form, that is squares of light intersected with black squares. When these black squares just touch each other at the corners, the screen is at the proper distance from the ground-glass for the principal exposure with the normal stop. The screen should be fixed here, as this is the focus for that reduction or enlargement.

To Choose the Highlight Stop. — If iris diaphragms are being used, have an assistant open the iris very slowly while the effect is studied on the groundglass with the focusing magnifier. The dark squares will grow smaller until they become isolated dark dots. Just before they entirely disappear, the aperture is found for the highlight exposure, and this should be noted. With Waterhouse stops, the same method is adopted. The stops are changed in the lens slot until one is found that gives a small, dark dot on the groundglass.

The Shadow Stop. — To secure small dots even in the deepest shadows of the halftone it is customary to cover the copy with a sheet of white paper and expose the sensitive plate to this paper with a very small stop for a few seconds. This is called "flashing." The size of this stop may be determined by again noting the effect on the ground-glass with small stops in the lens. When the stop

is too small, it may produce a screen-image, but when it is the right aperture it will show bright dots of light on the groundglass. After the flash exposure is made, the white paper is removed and the exposure with this shadow stop may be continued for a long period to strengthen the dots between the shadows and the halftones and also the center of the highlight dots. It will be understood that the smaller this shadow stop, the longer will be the exposure required with it. These small, strong dots in the shadows, obtained through long exposure with a small stop, will withstand the "cutting" solution during the treatment of the negative later.

Some Principles of Halftone Negative-making. — The student should learn that the nearer the screen is to the sensitive plate, the more the screen will show, at the sacrifice of gradation in the halftone negative. The same effect is obtained when stops which are too small are used. The farther away the screen is from the sensitive plate, the greater the gradation in the negative, with the danger that the dots in the highlights will be closed up. The same result will be obtained by the use of stops which are too large, or by overexposure.

Overexposure is less of a fault in halftone negative-making than underexposure, because overexposure can usually be corrected with the cutting

solution, while intensification cannot make up for loss of exposure.

As the bellows of the camera is extended, the screen separation increases, and vice versa. As the camera is closed up for reduction, the screen separation should decrease proportionately.

Long-focus lenses require much screen distance. Short-focus lenses need short screen distance.

The screen opening is in the same proportion to the screen distance, or separation, as the aperture in the diaphragm is to the distance between the diaphragm and the sensitive plate, so that, knowing any three of these factors, it is easy to calculate the fourth.

The coarser the screen used, the larger the diaphragm aperture; the finer the screen, the smaller the diaphragm aperture. The larger the diaphragm aperture, the shorter the exposure, and the smaller the diaphragm aperture, the longer the exposure required.

A fixed screen distance can be kept for all reductions and enlargements with each screen used. The only change to be made is in the size of the stops used, these being larger for enlargements and smaller for reductions.

To Determine the Proper Exposure. — The most important factor in halftone negative-making is to judge the correct exposure. The student will find this exposure problem much easier

to solve than it might appear if he will but keep a record of all exposures, both failures and successes, so that he may not repeat mistakes of judgment. The plan for obtaining at one trial most information regarding the proper periods of exposure is adapted from *Horgans' Halftone and Photomechanical Processes,* page 94, which is now out of print. It recommends making three exposures on a single sensitive plate, the subject being a photograph with plenty of lights and shadows in it.

Let us suppose the copy is strongly illuminated and the reduction is one-half. The normal round stop required, to reproduce the copy sharp to the corners, is $\frac{1}{4}$ inch in diameter, the highlight stop is $\frac{1}{2}$ inch, and the shadow stop is $\frac{1}{8}$ inch. We will make out a tentative table of trial exposures like this:

A. Shadow stop . . $\frac{1}{8}$ inch diameter . . . Exposure 4 minutes
B. Normal stop . . $\frac{1}{4}$ inch diameter . . . Exposure 2 minutes
C. Highlight stop $\frac{1}{2}$ inch diameter . . . Exposure $\frac{1}{2}$ minute

Three Trial Exposures. — The three trial exposures are made on the same negative in this way: After placing the plateholder containing the sensitive plate in the camera, draw the slide so as to uncover for exposure only one-third of the plate; this we will call exposure A. Then by drawing the slide again, expose two-thirds of the plate for exposure B, and finally expose the whole plate for exposure C.

Before making exposure A, the shadow stop has been inserted in the lens; then remove the cap from the lens for four minutes. For exposure B the normal stop is inserted in the lens, and the cap withdrawn for two minutes. For exposure C the highlight stop is inserted in the lens, and the lens uncapped for one-half minute.

What These Trials Teach. — Development of this plate will exhibit on section C the effect of the highlight stop alone; section B will show the effect of the highlight stop and the normal stop, while section A will demonstrate the result of the exposures with all three stops. To study properly the effect of these trial exposures, the negative, after fixing in cyanide, should be intensified with copper and silver, as explained in the chapter on line negative-making.

After intensification, if the shadow dots are intense enough in section A, while the checkerboard pattern is not strong enough in the middle tones of section B, or even in section A, and should the highlights not show a tendency to close up in section C, then the exposure with all three stops has not been long enough. Should one or two of the exposures be sufficiently long this trial negative will show it. If on the other hand the exposures seem to be carried too far, then try the effect of " cutting " the negative as explained next.

The Cutting Solution. — On examining a

halftone negative with a magnifier in a strong light, but with a dark background, a translucent fringe will be noticed around each dot. This fringe can be dissolved away, leaving the dots crisp and sharp, with what is called a "cutting" solution. This cutting solution is made as follows:

A. Water	10 ounces	300	cc.
Potassium iodide	1 ounce	30	g.
Iodine crystals	½ ounce	15	g.
B. Water	10 ounces	300	cc.
Potassium cyanide	½ ounce	15	g.

For use take ½ ounce (15 cc.) of the iodine solution A in 10 ounces (300 cc.) of water, and add the cyanide solution B slowly to the wine-colored iodine solution until it just becomes transparent. This is the cutting solution.

Two Ways of Using the Cutting Solution. — The cutting solution can be flowed over the negative, as the developer was used, and drained back into the container. Now watch its effect in dissolving the fringe in the highlight apertures and around the shadow dots. It should work very slowly. If it appears to operate too rapidly, dilute it with water. It is well to do this cutting over a sink with the water running, so that if the action of the cutting is found to be too rapid, or when it is sufficient, it can be stopped instantly by flooding the negative with water.

Another way to use the cutting solution is to take

1 ounce (30 cc.) of the stock solution A and dilute it with 10 ounces (300 cc.) of water. Flow the halftone negative with this, draining it back into the bottle. Repeat until the film turns a cream color right through to the glass support. Rinse under the tap, and flow with the B solution, also diluted ten times with water. As the transparent dots will, by reflected light, appear black against a light cream ground, the action of the cutting solution can be easily studied. Local treatment can be given by dropping the B solution only on those parts that require to be darker. When the whole halftone negative appears a trifle darker than the finished halftone should appear, the cutting is sufficient. Then the negative is washed and blackened with:

Sodium sulphide	½ ounce	15 cc.
Water	10 ounces	300 cc.

This is flowed over the negative and permitted to blacken it through to the glass. After this the negative is again washed, and examined to see if it is opaque enough. If it is not sufficiently opaque, the intensification with copper and silver, which preceded the cutting treatment, can be repeated, and the negative again blackened with the sodium sulphide solution above. A slight discoloration of the negative can be removed with a weak solution of nitric or hydrochloric acid. After this the negative is put in a rack to dry.

It is only in the use of the halftone screen and the cutting solution that halftone negative-making differs from that of line negatives. The negative stripping and turning are the same as described in the directions for line negatives.

Copper for Halftones in Place of Zinc. — Excellent halftones are made on zinc by the albumen method, as described for making line engravings. Copper is preferred for engraving halftones for several reasons:

First: the enamel acid-resist used on copper gives a smooth edge to the halftone dots. With the albumen method, the ink-covered dot, when dusted with resin, frequently has adhering to its edges grains of resin which give it a ragged edge when etched. The enamel resist, not requiring the protection of powdered resin, is free from this defect.

Secondly: There is danger of destroying the character of the zinc or melting it when enamel is used on it, as such a high degree of heat is required to render the enamel impervious to acid. Zinc melts at 700° F. (371° C.) while copper requires 1929° F. (1054° C.) to melt it.

Thirdly: The re-etching of local areas can be done on the enamel without danger, while the ink and powdered resin resist are not sufficiently strong to stand such treatment.

The Halftone Enamel. — The basis of the best enamel is fish glue. This has been found to be the most reliable, though gelatin, gum arabic, albumen, sugar, and other substances are frequently added to it. The simplest formula for a reliable enamel solution will be as follows:

Water	3 oz.	90 cc.
Fish glue	1 oz.	30 cc.
Ammonium bichromate ..	36 gr.	2.33 g.
Aqua ammonia	3 drops	3 drops

These figures can be multiplied as many times as there are ounces of fish glue used. The bichromate can be dissolved in the water first, then the glue stirred in and the whole carefully filtered, after which the ammonia is added. This should turn the color of the solution from a light orange to a pale yellow. If it does not do so then more ammonia can be added, drop by drop, until the solution becomes a pale yellow.

Temperature has a powerful effect on fish glue, it being more liquid when warm than when cold. It also decomposes quickly in heat. Kept on ice in the dark, it will be in condition to use for many days.

Enamel Formula with Albumen. — The addition of fresh egg albumen to the fish-glue enamel increases its sensitiveness to light, and aids in giving a sharper image on development. The following formula will work satisfactorily:

Water	5 oz.	150 cc.
Fish glue	2 oz.	60 cc.
Albumen	1 oz.	30 cc.
Ammonium bichromate	100 gr.	6.5 g.
Aqua ammonia	10 drops	10 drops

The albumen from a fresh egg should be well beaten up into a froth and allowed to settle. Then 3 ounces (90 cc.) of the water is stirred in and the glue added. The bichromate is dissolved in the remaining 2 ounces (60 cc.) of water, and poured in slowly while the mixture is briskly stirred. After carefully filtering a couple of times, the ammonia is added.

Cold Enamel. — An enamel made with shellac as the acid-resist is supplied by the trade ready for use.

Preparation of the Copper. — Copper sheets with a polished surface for engravers' use can be purchased. In thickness they are 14 gauge (2 mm.) or 16 gauge ($1\frac{1}{2}$ mm.). During the machine grinding and polishing, oil or grease is used to keep the gritty particles in contact with the copper. This leaves on it a film of grease that must be gotten rid of completely, before the enamel coating will properly adhere to the copper surface. To remove this grease, it is best to heat the copper and scrub it back and front with caustic potash or other alkali solution. Whiting moistened with an alkali can also be used. After the copper is free from grease, it is well to go over its surface with polishing char-

coal, in the direction of the original polishing. This removes the high polish and gives the copper surface a slight grain, to which the enamel will adhere better.

To Get an Even Enamel Film. — To secure a thin and even film of enamel on the polished copper is most important, and though this might be done, through practice, just as a glass is coated with collodion, still the proper way to do it is with the aid of a "whirler." There are many devices of this kind in the market.

After the copper plate is polished with charcoal, and washed free from clinging charcoal particles with a tuft of wet cotton, it is flowed, while still wet, with the filtered enamel solution from a wide-mouthed bottle. The first coating is simply to drive the water from the plate and should be allowed to drain into the sink. The plate is flowed a second time with the enamel, and if the coating is free from specks or bubbles, which can be removed with a point of wood, the plate is quickly inverted and fastened in the whirler, and then started revolving several inches above the heat so that it may be dried slowly. On the speed at which the plate is whirled depends the thickness of the enamel film. The student will soon learn by practice the speed necessary to obtain the best enamel coating with the formula and temperature in which he works.

It is necessary that a circular guard be used to

catch the excess of enamel solution flung from the plate while whirling. This can take the form of a wide and deep circular tin vessel in the bottom of which a small gas or oil stove is placed to furnish the heat to dry the enamel. Remember dried enamel is sensitive to daylight.

Care should be taken that the copper does not get warmer than the back of the hand will bear. When the enamel is dry, it should be glossy in appearance like a varnish, and so transparent that the copper is easily seen through it. If the enamel contains any specks, it should be washed off immediately and the copper plate recoated.

Exposure of the Enamel to Light. — The operation of exposing a sensitized copper plate to light is precisely similar to that previously described when zinc is used. When putting the halftone negative and the enamel-coated copper plate in contact with each other, face to face, it is important that they be of the same temperature. If one should be warm and the other cold, a sweat is likely to form which may cause them to stick together, for it must be remembered that the enamel coating is a powerful cement when wet.

Before the halftone negative is placed in the printing frame, it should be examined with a powerful magnifier to judge how much exposure to light the finest dots will require, while the opacity of the

negative must be noted to determine for what length of time a negative of its density will hold back powerful light rays.

When the negative and copper plate are locked up in the printing frame, look through the plate-glass. If the copper can be seen through the finest dots in the negative, the exposure will be comparatively short as compared with that required for one in which the highlight dots in the negative are filled up. The value of clearing out these dots with cutting solution when the negative was being made will be recognized at this time when printing from the negative on copper.

A Trial Exposure. — It is well to make a trial exposure by putting the printing frame in direct sunlight or electric light. Cover it up completely at first with opaque cardboard. Then give exposures of one minute each to first one-third of the plate, then two-thirds, and finally the whole plate. This will result in the three sections of the plate receiving exposures to sunlight of three, two and one minutes, respectively.

With electric light a similar experiment can be carried out by standing the printing frame vertically on the edge of a table, one foot (300 mm.) away from the electric arc, and giving two or three times as much time for each exposure as that given in sunlight. The plate-glass in the printing-frame can be kept cool with a sponge and water, as it will

not do to allow the enamel to get too hot. The exposures to electric light might even be from three to ten times that required by sunlight, depending of course on the strength of the current.

Coloring and Developing the Enamel. — After exposure to light, the copper plate is carefully lifted, so as not to scratch the negative or the enamel surface, and is laid for a minute or more in a tray of water strongly colored with an aniline dye, until it is saturated with the dye. Cotton blue gives the best contrast with copper though methyl violet, eosine red, or any dye soluble in water can be used. No particular strength is essential, though 1 ounce (30 cc.) of methyl violet to 25 ounces (750 cc.) of water is common practice.

The enamel absorbs the coloring quickly. The plate is lifted out of the dye and held under a tap of running water to develop the image, which should appear almost immediately, beautiful in color on a copper background. If some of the finest dots in the shadows do not open up, the development of these can be assisted by pouring on them a stream of warm water from a vessel with a spout, such as a tea or coffee pot, or the development of these fine dots can be assisted by gently touching them with wet cotton. The enamel image is very tender at this stage, so that the warm water treatment or development with cotton must be done carefully.

Was the Exposure Time Correct? — Should the entire enamel coating come away on development, the exposure to light was not sufficient. If the image fails to develop, the exposure to light has been too long, or the negative is not opaque enough, or both. The copper should in either case be recoated, first using clean caustic potash solution to remove the enamel, after which it is well to repolish the surface with charcoal as before.

The Film Called "Scum." — There is frequently left after development in some of the small cavities in the enamel a transparent veil or film of enamel called "scum." This is a cause of much trouble later, so the beginner should watch out for it. If it is detected when developing, the warm water treatment will frequently remove it. Should scum be allowed to remain on the copper, it will later prevent the etching solution from reaching the copper it covers. Scum is most frequently evident in the fine dots in the shadows. When there is a suspicion of scum being on a plate some etchers remove it after "burning in" the enamel, with the following solution:

Water	10 ounces	300 cc.
Table salt	2 ounces	60 cc.
Acetic or hydrochloric acid ..	1 ounce	30 cc.

Some of this is poured on the baked enamel surface and rubbed vigorously with a stiff bristle brush wherever scum is suspected, until every dot on the

copper surface shows equally bright. Then the scum has been removed. Wash the enamel quickly, and dry.

Drying and Burning-in. — Let us go back to the developed enamel print. It should be allowed to dry either in the air, or by flowing over it a few times wood (methyl) alcohol to absorb the water from it. This will very likely also remove the coloring matter, which is no longer needed, and which would disappear on heating the enamel.

When the enamel print is dry, the edge of the copper plate is gripped with the wide-mouth pliers, and the plate held over the intense blue flame of a gas stove, keeping it moving so that every part of the copper will be evenly heated. As the heat increases, the enamel turns yellow, gradually darkening to brown and finally to a chocolate color, when it is sufficiently carbonized or " burned in," as it is termed.

The copper itself appears at first red, which sometimes changes to a silvery appearance. Should the enamel coating turn only to a grey and not brown, the enamel film is too thin and will not withstand long etching. It should be cleaned off with caustic potash, and the copper recoated, taking care not to whirl the plate so fast the next time.

After the enamel is burned in, the copper plate should never be cooled suddenly, as it destroys the temper of the metal. It is better to stand the copper

plate against the wall until it is cool. Then paint around the image on the face, and cover the back and edges with asphalt varnish as a protection against the etching solution. Retouching can now be done with asphalt varnish and a fine brush.

Copper Etching Solution. — Iron chloride, ferric chloride, and iron perchloride are different names given to the solution for corroding or etching copper. It can be purchased either in lump form or in solution. The yellow-brown lumps are put in acid-proof stone-ware jars and covered with water, when the lumps will dissolve, forming a solution that will register strengths varying from 35° to 40° Baumé. The more this solution is diluted with water, the more danger is there of it softening the enamel resist, so that most etchers prefer to use the iron chloride at a strength of 40° Baumé. It etches better when it has a little old etching solution mixed with it, say one part of an old bath to three parts of a new one. An iron chloride etching bath can be used over and over again until it becomes almost saturated with copper, and deposits, when at rest, a sediment of copper-iron salts on the tray bottom.

Etching Face Down. — The iron chloride solution is used in an earthenware, porcelain or hard-rubber tray, for it will corrode most materials of which trays are made, unless they are well protected from its attacks by tar, pitch, asphalt, or

shellac. Where haste is not essential, it is recommended to etch the copper halftone by turning it face down in the iron chloride etching solution and leaving it there. Small blocks are used to keep the face of the plate as far away from the bottom of the tray as possible.

When putting the copper plate into the etching bath the enamel face must be first wetted and then drained and the copper slid face down into the iron solution to prevent the formation of bubbles on its under surface, as each bubble would prevent the action of the iron at the spot covered by the bubble. After a slight etching, for a period of say five minutes, the copper plate is removed to learn if it is being etched evenly over its whole surface. Should scum interfere, it is removed as previously instructed, and the plate returned to the etching bath.

The principle of this system of etching is that, as the iron chloride combines with copper, it becomes heavier and falls to the bottom of the tray, while fresh iron chloride takes its places to attack the exposed copper. The time required to etch a halftone plate face down depends on the temperature of the solution and the fineness of the screen. A halftone of 150 lines to the inch (60 lines per cm.) should be etched in 20 minutes, while a halftone of 85 lines (34 per cm.) might require 40 minutes.

The temperature of the iron chloride bath has

a great influence on the speed at which the etching proceeds. An iron chloride solution which at 60° F. (15.5° C.) will etch a copper plate deep enough in 20 minutes, will at 110° F. (43° C.) etch it in one-half the time, though a rise in the temperature of the etching solution increases the danger of its penetrating the enamel resist.

Still Etching, Face Up. — The method just described is called " still etching," to distinguish it from that in which the plate is rocked in the etching bath. Still etching can also be done with the plate resting face up in the iron chloride solution. The copper should be raised from the bottom of the tray so that the etching solution, as it becomes saturated, can flow from the surface of the copper and fall to the tray bottom. A drawback to this method is that the sediment will remain in the cavities which are being etched, thus delaying the corrosion. For this reason still etching face up requires double the time of etching face down.

It is necessary to use, at intervals, a camel's hair or other fine-haired etching brush to remove the sediment from the etched cavities, while the plate remains in the solution. It is better not to wash an enamel-coated plate with water during the etching operation, as this tends to soften the enamel.

Rocking the Etching Tub. — The commoner practice is to rock the tray slowly while the iron chloride is etching the copper, and at the same

time frequently brush the sediment from the face of the plate. This reduces the time of etching to one-half that required in etching a plate face down and one-third that for etching a similar plate face up. Rocking the tub has the further advantage that the plate can be watched as the etching proceeds. If a portion is not etching fast enough, the action can be accelerated in that area by brushing with the fine-haired etching brush. When the finest dots in the highlights are as small as it is safe to etch them, the plate can be raised from the tray, and the etching action instantly stopped by flooding the plate with clean water.

Danger of Undercutting. — "Undercutting" is what the etcher fears most. It is a corrosive action of the acid underneath the edges of the metal printing surface. Undercutting is most liable to occur when the etching solution is used in a rocking bath, for then the acid tends to flow against the sides of the lines or dots, while it is least liable to occur in still etching, particularly when the copper plate is turned face down. While in etching copper halftones it is desired that the iron chloride shall deepen the spaces between the lines and dots, it must be remembered that etching solutions attack a metal in all directions with equal vigor, so that the iron chloride is corroding the sides of the dots as well as deepening the spaces around them.

When making the halftone negative, in using the

cutting solution, and in printing from the negative on the copper, it must be remembered that as the etching proceeds in depth, the sides of the dots will be corroded so as to reduce their printing surfaces. When etching zinc this factor need not be considered, as after a slight first etching, the sides of the lines or dots are protected with a powdered resin acid-resist. With etching machines, in which the acid solutions are hurled at the plate in a spray, this lateral action of the acid is not so great.

The Deceptive Enamel Dot. — In etching copper, when the iron chloride dissolves away the sides of lines and dots, it leaves the enamel intact, unless this overhanging fringe of enamel is brushed away during the etching. In the case of the smaller dots this enamel covering spreads out over the dots like the top of a toadstool, or an open umbrella, giving no idea of the size of the dot supporting it. So it is well to stop the etching before the appearance of the enamel on the smallest highlight dot would warrant it, for these highlight dots can be made smaller later in the re-etching.

When examining a copper plate with a magnifier during the etching it is customary to blow the etching solution away from the spot being examined instead of washing it, so as to avoid the possible softening action of water on the enamel resist.

Staging. — If a portion of the plate has been etched sufficiently, the copper can be taken from

the bath, rinsed quickly with water, the water absorbed from the surface with the pad of damp chamois skin, and dried over heat. While the plate is warm, asphalt or shellac varnish is painted over the area requiring no further etching. Then the plate is put back in the iron chloride and the etching continued. This operation can be repeated as many times as necessary, and is called " staging."

Re-etching. — When the etching is finished, the copper plate is taken from the bath, washed and dried. It is now brushed with a nail brush to get rid of the fringes and umbrellas of enamel previously described. After this is done, the halftone is rubbed over with a block of carbonate of magnesia and the surface polished clean with the palm of the hand. This operation fills in with white the corroded portions of the copper, showing the halftone dots in brilliant contrast, thus giving one a better idea of the condition of the plate than an impression in ink would.

All manner of changes can now be made in the halftone plate. It requires artistic training and judgment to do it properly. The most successful re-etchers are those with an art training, sometimes combined with experience at wood engraving.

The halftone is now studied in comparison with the copy to see if the shadows or dark portions of the halftone are as dark as those in the copy, and if the light areas are light enough. Those areas of

the halftone that are dark enough are painted over with asphalt, or with shellac so colored as to be easily seen. The dots in the highlights are examined with the magnifier to determine how much more etching they will withstand, and the cavities in the shadows to see if they are deep enough.

To re-etch the highlights the halftone is laid on a level surface, a Chinese marking brush is saturated with iron chloride, and a pool of the iron solution is put on the spot requiring the most re-etching. This pool is spread around so as not to leave abrupt edges between the old and the new etching. When the re-etching appears sufficient at any point, the action is stopped by soaking up from the plate the iron solution with pieces of blotter, at hand for that purpose.

It will be easily understood that this re-etching and lightening of different areas of a halftone can be carried on indefinitely. Refilling of the re-etched parts with magnesia keeps the worker informed as to how the work progresses. Should the enamel leave the surface at any spot, no further re-etching can be done there. Darkening of any portion of the plate can be accomplished after the etching is completed by removing the enamel from that portion and burnishing the copper with a tool made for that purpose. Burnishing the halftone is not recommended, as it lowers the surface of the copper where it is used and gives the printer trouble later.

How to use engraving tools, roulettes and burnisher, can be learned only by practice with them, so that instruction here would be useless.

Vignetting. — If it is necessary to grade off the margins of a halftone so that the dots disappear entirely at the extreme edges, a border of asphalt or shellac varnish is painted around the halftone just where the finest dots are to leave off and the white paper begin. The central area that is not to be affected by the vignette is also covered with varnish. To avoid a hard marginal edge on this varnished central area, lithographic crayon is rubbed on the halftone dots around this edge, vignetting it just as one would a crayon drawing. Now, with the Chinese marking brush full of iron chloride, re-etching is begun just at the outside varnish border line, spreading the solution so that it gradually encroaches toward the center.

Vignetting requires much patience guided by artistic judgment, and only the principles can be described here. It should not be undertaken on commercial work until after much practice on experimental plates.

Photoengraving Is Now Complete. — When the re-etching is finished, the asphalt varnish on the plate is removed with turpentine and the shellac with wood (methyl) alcohol. The copper is then freed from stains by scrubbing with the solution used for the removal of scum.

The photoengraving is now complete, and if the student has followed instructions and performed the operations intelligently, the result is a perfect half-tone engraving ready to be bevelled and blocked on wood. This work is done by machinery, the makers of which will be glad to supply instructions.

PART III

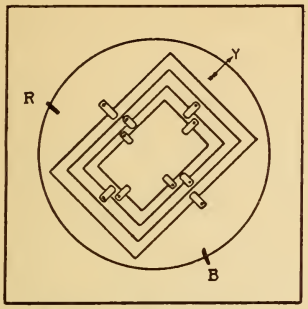
PHOTOENGRAVING IN COLOR

To the original *Photoengraving Primer* is now added what the practical photoengraver should know to take up color photography for making plates to be used in color printing. Science has made it easy for the photoengraver to apply color plate making to his profession. In wet-plate photography the photoengraver must compound his own solutions for sensitizing his photographic plates, and learn by experience how to keep them in working order. With color plate making the sensitized dry plates are prepared in costly laboratories by skilled scientists who furnish detailed instructions for using them. Proof of what science has done to simplify dry-plate photography is shown by the accomplishment of amateur photographers, many of whom are already leaders in color photography. The most valuable and interesting hobby the engraver could take up during his leisure hours is color photography with a miniature camera. In this manner he will learn the principles from the best teacher — experience. A bibliography of books on color photography will be found on page 101.

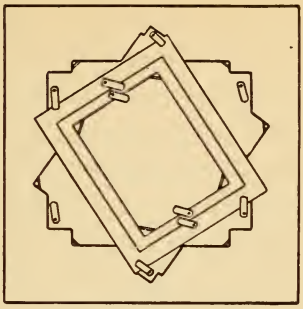
Color Blindness. — In my association with artists for over fifty years I found so many of them color blind to a degree that I wrote in 1902 this introduction to a small book on "*Three-Color Process Work*":

"The person contemplating three-color photography, should not trust his own judgment as to whether his color vision is normal, but have his eyes tested for color blindness. Some eyes lack entirely any appreciation of the sensation of red; others fail to distinguish green, while a few are blind to the violet sensation. There are degrees in the defectiveness of eyes to the color sensations, perfect color vision being rare. The nearer to normal ones color vision is, the better one will succeed at three-color photography." Color blindness is becoming increasingly evident when examining candidates for military service and automobile driving.

An Additional Darkroom. — The wet-plate photographer has in use a copying camera, electric lights, and much other equipment that might be used in color photography. It would be advisable to construct at once an additional darkroom for dry-plate photography exclusively. This room must be absolutely light proof with ruby and green safelights as well as a white light for use when necessary. It should also be well ventilated and must be kept strictly clean and free from dust. A long sink with



ROTARY COPYBOARD



CHANGEABLE KITS

Two methods for holding transparencies when making three-color halftones at proper angles.

two taps of running water should be provided, one end for developing and the other for washing. There should be shelves for trays, printing frames, plateholders, storage for dry-plate boxes and chemicals. The developing tank can stand in the sink.

Other Equipment. — The copying camera should have a transparency holder to replace the copyboard when copying or enlarging negatives from small color positives. In 1902, before the revolving screen was available, the writer recommended a rotary copyboard with an opening in it for kits that would take any sized positives. The circular portion of the board, like a revolving halftone screen, had marks on it to bring the positives to the proper angles when making halftone negatives. The halftone screen remained in the camera while the colored positives or other colored copy was turned to the necessary angles.

Apochromatic Lenses. — For the making of color-separation negatives it is essential to use an apochromatic lens: one that will bring all colors to the same focus on the groundglass, so that the separated negatives will register exactly. Leading lens makers pride themselves on the accuracy of their apochromats. If you possess a Cooke " Apochromatic," a Goerz " Atar," Voightlander " Apochromatic Collinear," or a Zeiss " Apotessar " you have the best lenses made for color photography.

Autochrome, Now Called Filmcolor. — In 1904 Lumière invented a color screen and panchromatic emulsion combined on a dry plate. The color screen consisted of minute spherical starch grains dyed red, yellow and blue. These were thoroughly mixed and spread over a thin glass plate coated with an adhesive to which the colored grains adhered in a single layer. These grains were pressed flat, the crevices between the grains were filled with carbon black, the whole varnished and then coated with a panchromatic emulsion. In a single exposure through the glass the three colors were recorded. After developing the exposed plate into a negative and redeveloping it into a positive, the latter containing the colors of the original was used by photoengravers as color copy in the transparency holder of the camera to make three-color halftone printing plates. Autochrome plates have been improved and are now called Filmcolor.

Agfacolor Ultra Plates. — Agfacolor screen plates are similar to Autochromes except that dyed resin grains have taken the place of starch grains. These plates are supplied by the Agfa Ansco Corporation, Binghamton, N. Y. with branches in the principal cities of the United States. An advantage of the Agfa grained plate is it can be used in any plate camera. No color filter is required over the lens in out of door work. The operations after exposure are, in brief, these: First development, brief wash, removal of negative in reversing solution, wash, exposure to white light, redevelopment in original developer, wash, intensification or reduction if necessary, drying, varnishing and binding. The colored positive can now be used as copy for making color-separation negatives in a transparency holder in the camera. The book of instructions supplied with these plates covers every detail when handling them.

Dufaycolor. — This is one of the methods for making motion pictures in color. Pictures of the King of England's Silver Jubilee were made on this film. The acetate base is covered with a mosaic of color filters in the form of alternate blue-violet and green squares arranged in pairs alternating with a continuous red line. The mosaic is so fine, it is almost invisible to the eye. This mosaic screen of color filters is coated with a highly sensitive panchromatic emulsion. When photographing on Du-

faycolor film, the acetate base is turned toward the lens so that the light will pass through the color filters to the emulsion. It can be exposed without a filter, over the lens, in daylight. It is developed, washed for a minute, bleached in a potassium bichromate solution, well washed, exposed to a 100-watt bulb for 90 seconds, redeveloped, when it becomes a positive in natural colors. It is washed, fixed in hypo, well washed and dried. Color-separation negatives are made by putting the Dufaycolor positive film in a transparency holder, several inches in front of the copyboard, which is covered with white paper, evenly illuminated with arc or tungsten lights on each side. Panchromatic Process Plates are used when making halftone negatives as with any colored copy. Complete instructions come with the Dufay plates including their factors.

Color Positives by Other Methods. — To the fortunes spent in seeking colored movies we owe many methods in color photography. Only those that use three colors are mentioned here:

Kodacolor is one of them invented by R. Berthon in 1908. Also known as Keller-Dorian process in 1928. Dr. Mees says of it in *Photography:* " It is not yet certain whether the process will prove to be feasible commercially."

Technicolor is the result of over twenty years experiments in motion-picture photography. Three color-separation negatives are made by a single ex-

posure in a special camera. From these separations relief positives are photo-printed on bichromatized gelatin and dyed in proper colors by the imbibition method.

Belcolor is a simple method of securing positives in color from three color-separation negatives. Thin celluloid coated with gelatin, dyed red, yellow, blue and black, in sizes up to 19½ by 23½, are in the market. When these are sensitized with potassium bichromate and photo-printed from color-separated negatives the results are brilliant color positives from which halftone negatives are made in the usual manner.

Lumière Filmcolor is the new name for improved Autochrome, the first successful method of making color records in a single exposure. Autochrome with its emulsion over colored starch grains on a glass plate is now supplied with film base. It has much greater speed than formerly. R. J. Fitzsimons Corporation, 75 Fifth Ave., New York, are Lumière agents.

Chromatone comes from the Defender Photo Supply Company, Inc., Rochester, N. Y. It is a thin collodion stripping paper on which natural color prints can be made from three color-separated negatives. The formulas for developing, bleaching and dyeing the papers are supplied by the manufacturers who will send inquirers the latest booklet on the subject.

Dyebro Relief is a modification of the Autotype Trichrome Carbro, described elsewhere. With Dyebro pigment tissue comes Dyebro dyes and full instruction for using the method.

Duxochrom and **Colorstil** are further methods of making color prints, the materials and instructions for which are supplied by Ruthenberg Color Photography Co., 4961 Sunset Boulevard, Hollywood, California.

Autotype Trichrome Carbro. — Here is a method of getting three-color prints on paper from color-separated negatives that has been found satisfactory by leading color engravers, advertisers and printers in England, America and other countries. This writer witnessed the procedure at the Autotype Works in West Ealing, England. Of course, the workmen were experts, and in their hands the process looked very simple as they handled three-color carbon prints as large as 16 by 20 inches and superimposed them in register so easily.

The principle of the method is briefly this: from color-separated negatives, prints are made on selected bromide paper. The Autotype Company supply carbon tissues in red, yellow and blue colors. These colored tissues are soaked in potassium bichromate " bleaching " solution, while the bromide prints are soaked in water. When both are wet, a bromide from a blue separated negative is squeegeed in contact with a blue carbon tissue, a red

separation bromide with red carbon tissue and the yellow carbon treated in like manner. This contact sets up a chemical reaction between the exposed silver in the bromide prints and the bichromated carbon tissues which hardens the gelatin in the carbons in exact ratio to the amount of silver in the bromide prints. When the bromide prints are pulled away from the carbons the latter will be, when washed in warm water, strong positives in red, yellow and blue. These can be superimposed in register as permanent photographs in color, or worked over for advertising purposes and sent to the photoengraver for halftone printing plates. Several books have been written about Autotype Trichrome Carbro. One that can be recommended is *Natural Color Processes* by Carlton E. Dunn, published by American Photographic Publishing Co., Boston, Mass. Mr. Dunn knows his subjects thoroughly and is a demonstrator of Autotype and other color methods.

Kodachrome. — This was the miracle in color photography of 1935. It was taken up by amateurs with small cameras and in June of that year magazines blossomed with most satisfactory color illustrations enlarged from Kodachrome film positives, 1 by $1\frac{1}{2}$ inches in size. The first article on this wonder process describing how leading photoengravers made halftones for color printing in perfect register that were frequently enlarged one hundred times the

area of the miniature original in colors, was published in the *Photo-Engravers Bulletin* for September, 1937, pages 55 to 58. Kodachrome is supplied by Eastman Kodak Company to whom the film must be returned for processing. They return a positive in color, same size as the original film negatives. The positive film is free from grain so that it will stand great enlargement. Dr. C. E. Kenneth Mees describes the film itself and the intricate machinery used in processing it in his book *Photography* published by Macmillan.

The Eastman Wash-off Relief Process. — This is an imbibition method, as is used by the Technicolor Company for their motion pictures in color. Three relief gelatin images are made from color-separated negatives. These images are each dyed in one of the primary colors and either stripped over each other in register to make a positive in full color, mounted between glasses like a lantern slide, or, the dyed relief images may be pressed on gelatin-coated paper, each one remaining under pressure for the color to be imbibed. When the three are pressed over each other three-color prints on paper are obtained.

The Finlay Color Process. — This is a method of getting photographs in colors by one exposure on a single glass plate. It requires a special panchromatic plate, and a Finlay taking screen with a compensating filter. After the proper exposure

is made on the panchromatic plate through the taking screen which is placed in absolute contact with the sensitive plate, the panchromatic plate is developed, for example, in a glycin developer, fixed and dried as usual. The Finlay Color Process shows the colors in squares the size of the squares in a 175 line halftone screen. Any number of positives can be made from this negative in a printing frame on process dry plates, after development of which a Finlay viewing screen is clamped in perfect register and contact with the positive and the result is a reproduction in colors of the original subject. A positive combined with a Finlay viewing screen can be used in the camera transparency holder to make three color-separation negatives for three- or four-color halftone printing. The Bassani Processes, Inc., N. Y., supply a screen to block out certain colors when making color-separation negatives from Finlay positives when photographed through a taking screen.

Color Filters. — Wratten color filters cover all the requirements of color photography and for all makes of color-sensitive dry plates. Get acquainted with their number and uses before beginning color work. Lists of them, their uses and the time factors are supplied. The time factors should come with the panchromatic plates. These time factors vary of course with the kind of light, whether daylight or artificial light. From the makers of

each pan plate should come the time factors for arc lights, incandescent tungsten lamps, as well as the recommended formulas for developers, and other solutions used. Color filters come between glasses called " optical flats " or in a cheaper form, as gelatin filters. The latter are used by photoengravers in the Waterhouse slot in the lens. Filters should be kept between the leaves of a small book when not in use to protect them from dust and the possibility of fading in strong light.

Cramer Plates. — The first successful American dry plate manufacturer was Gustav " Pop " Cramer in 1881. His isochromatic plates were used by this writer in 1894 for making halftone negatives direct from color copy. Only the slow iso of that time had to be bathed, in absolute darkness, in cyanin dye and left to dry over night for use the following day. By 1906 they had a panchromatic plate on the market and today the Spectrum and Spectrum Process plates are sensitive to all colors. For this reason they should be handled in total darkness or in the dull gleam of the safest of safelights. Their book *Process Photography and Plate Making* by J. S. Mertle, tells in detail all about their products.

Eastman Kodak Company. — The products of this company are so well-known and they supply information connected with color photography so readily, the reader is advised to write for their book-

lets on *The Photography of Colored Objects, Wratten Color Filters, Kodachrome, Eastman Wash-off Relief* and other literature on films, plates and filters for commercial color photography.

Ilford Products for Color Photography. — This writer spent much time in the Ilford laboratories at Ilford, London, England, and witnessed the care taken in the scientific testing of every detail in the manufacture of the panchromatic plates and films that are shipped to all countries in the world. Besides eleven different pan emulsions on glass plates and thirteen emulsions on film for monochrome and orthochromatic photography, they offer to the three and four-color photographer six panchromatic emulsions on glass and three pan emulsions on films. These have an anti-halo backing and are on groundglass for retouching purposes, when required. They supply color filters, step wedges, safelights and color sensitive plates for photoengraving, photolithography, photogravure and collotype. Their distributor in the United States is the R. J. Fitzsimons Corporation, 75 Fifth Ave., New York, who will send on request a beautiful catalog of Ilford Products for photoengravers' use.

Circular Screens. — For four-color halftone negative making circular screens are now in general use. These are mounted in a holder so they can be rotated to the special angles required. These circu-

lar screens are also used in making Duographs (see index), as well as halftones for three-color and five-color printing. The standard circular screens are from 13½ to 44 inches in diameter. They cover rectangular halftones 8 by 10 inches to 28 by 34 inches in size. Though screens up to 58 inches in diameter, with any number of lines to the inch, can be made to order.

As to the proportion of transparency to opacity in screen lines the standard ruling is 50 to 50 and much experiment has been done without improving it. There is at the present time a call for screens with 40 percent transparency of line to 60 percent opacity.

The reason for using a yellow filter, when photographing on a pan plate in sunlight is that the blue, violet and ultra-violet rays are much more powerful in sunlight than in artificial light and the pan plate is still excessively sensitive to these rays. Through the use of a yellow filter in bright sunlight a truer record of the colors is obtained as seen by the eye. Some days, particularly in the late afternoon, the sunlight is so yellow in itself that a yellow filter is not required.

Gelatin filters have no appreciable effect on the size of the image. When using glass filters the object should be focused with one of the filters in its place before or behind the lens to prevent change of size in the negatives.

Desensitizing before Development. — The wet-plate photographer accustomed to develop exposed plates in a bright yellow light will not take kindly to developing pan plates in total darkness. It is a great advantage to see the image on its first appearance in the developer. This can be done by bathing the exposed pan plate for a minute or two in a dye called a " desensitizer " immediately before development. In this way the extra sensitiveness of the pan plates is reduced so they can be developed in a weak safelight without causing fog. The desensitizer does not affect the latent image. Some professional color photographers desensitize pan plates in a five percent solution of phenosafranin or cresosafranin, the latter dye is more easily washed out of the gelatin. Pinakryptol Green and Pinakryptol Yellow in 1 to 500 solution are frequently used for panchromatic emulsions. Ask the maker of the pan plates you use about desensitizing. Should you develop without using rubber gloves the slight yellow stain from the desensitizer can be removed from the fingers with two to three drops of perhydrol in the washing water.

Dry-Plate Developers. — " Developing photographic dry plates consists in converting the latent, or invisible image, produced by the action of light on the light-sensitive emulsion into a visible one. Chemically speaking, photographic development is a reduction process, in that the light-affected

silver particles are reduced to a form of quasi-metallic silver. In dry-plate development the sensitive light-affected salts are reduced to the metallic state by the use of reducing agents termed developers." In this simple manner does J. S. Mertle in his book *Process Photography*, G. Cramer Dry Plate Co., describe the scientific action of dry-plate developers. He continues: " These agents are, as a rule, weakly acid substances which only exhibit reducing properties in the presence of an alkali. Reducers for photographic development must be selective in their action, that is, they must confine their powers to those particles of silver affected by light, and must exert little or no action (within a reasonable time) on unexposed parts of the image.

" The constituents of a developing solution, together with their action and purposes, may be briefly classified as follows: (1) The developing agent or mixture of such agents (hydrochinon, metol, pyrogallol, glycin, etc.) which unites with the alkali or accelerator to form the true developer; (2) the alkali or activator (carbonates and hydroxids of sodium and potassium), whose function it is to hasten the action of the developer and to render the film more permeable by opening up the pores of the gelatin and giving more easy access to the developing solution; (3) the preservative (sulphites, bisulphites and metabisulphites of sodium and potassium), which prevents the too rapid oxidation

of the developing agent by absorption of oxygen and controls the color of the negative by preventing undue stain; (4) the restrainer (bromides of potassium and ammonia), whose action is to control the rate of development by retarding the action of the developer so that it will not affect unexposed particles of silver, and (5) the solvent water.

" The usual practice in mixing developers is to dissolve the chemicals in the order in which they are listed in the formula. It might be well, however, to append the following rules for mixing a developing solution:

" (1). The preservative (sulphites) should always be dissolved first, except in the case of a metol or metol-hydrochinon developer, when the order should be: metol-sulphite-hydrochinon-carbonate-bromide. The purpose of dissolving the preservative first is to prevent oxidation of the developer.

" (2). The temperature of the water should not exceed 125° F., as higher temperatures materially hasten the oxidation of the developing agent.

" (3). Always completely dissolve the first chemical before adding a second to the solution. Were the alkali to be added to a solution containing undissolved crystals of the developing agent, each crystal would become oxidized at the surface, and the solution would stain or fog.

" The rate of development is influenced by the quantity of alkali present, the temperature of the

developer, character and concentration of the developing agent, and the amount of restrainer present in the developer. The personal factor is eliminated to a large extent in the time method wherein the plates are developed for a stated time in a certain developer. Emphasis is laid on the fact that development cannot correct errors of exposure, although the degree of contrast in the negative can be controlled to a certain extent in development. To lessen contrast, develop for a shorter time, or dilute the developer: To increase contrast, use more alkali, or employ the developer at its greatest strength as long as the density of the silver deposit grows without the formation of fog."

Color-Separation Negatives. — To explain separation negatives in the simplest manner it should be remembered that when a photoengraver is given a page of black type to reproduce, he first makes the negative, on which the white paper is photographed, not the type. Therefore it is called a negative of the type because the type did not photograph. So it is in color separation. A red separation negative is one in which the green filter stops red from reaching the sensitive plate; the blue separation negative is one in which the blue should not photograph and the yellow separation negative is one in which yellow is supposed to be kept from reaching the pan plate. Filters are so called because they permit all colors to filter through to the

sensitive plate except the one of which a negative is wanted.

To repeat: To secure a yellow separation negative on a panchromatic plate, a color filter is inserted in the slot in the lens-barrel. This filter should permit all colors to reach the panchromatic plate except yellow. In the same manner a red negative is one in which the color filter stops the red rays from reaching the plate; and the blue separation negative is one in which the filter has stopped the blue and blue-violet from reaching the plate.

Glass plates as supports for the panchromatic emulsion are preferred to panchromatic films for the reason that the former are not so liable to give trouble in registration of colors in printing. In making color-separation negatives, grey wedges and a color chart (showing patches of the yellow, magenta and blue printing inks), as well as registry marks (usually crosses like plus signs on two sides of the copy), must be photographed on each negative. The grey wedges are necessary to determine density balance when developing the three negatives. The color patches serve to distinguish the negatives and the registry crosses enable the proofer and printer to register the colors at once. To get equal density in grey scales in the three negatives, multiply the normal exposure by the filter factor given for each color on the card which comes with the brand of panchromatic plates used. By practice

you will find the ratio of exposure necessary to meet your special lighting values.

Record Book of Exposures. — A book record of each exposure telling the date, title and description of the color subject, the brand of plates used, time of day or night (artificial light is frequently more reliable at night), stating amount of reduction or enlargement, diaphragms and filters used, precise exposure time in minutes and seconds, which developer used, in tank or tray, temperature of solutions and that of darkroom — followed by comments after negatives are complete, becomes a most valuable reference book, more valuable for study than any book on color-separation negative making that might be published. Such book records are carefully kept in all scientific laboratories.

Negatives should have full detail in the shadows without overexposing the highlights. This can be done with the proper filters and timing of the exposures. Develop the three plates in the same tray, or tank, at the same temperature.

The Black Key Plate. — The separation for the warm brown, black, or grey key plate is made in several ways. Ilford has a " Gamma " filter and Wratten has an orange filter for the same purpose. Some photoengravers give three exposures through the three filters on a single pan plate, each exposure being one-third that usually required.

BIBLIOGRAPHY

Clerc, Louis Philippe. The Ilford Manual of Process Work. 247 pp. Ilford, Ltd., Ilford, England.

Dunn, Carlton E. Natural Color Processes (2nd edition). American Photographic Publishing Co., Boston, Mass.

Eastman Kodak Co. Reproduction Work with Dry Plates for Three-Color Work. 48 pp.

Flader, Louis. Achievement in Photoengraving and Letter-Press Printing. 488 pp. Chicago, 1927.

Horgan, Stephen Henry. Horgan's Halftone and Photomechanical Printing Processes. (Out of Print.) John A. Tennant, 70 Fifth Ave., New York.

Horgan, Stephen Henry. Photoengraving Primer. Concise Instructions for a Practical Knowledge of Photoengraving. (Out of Print.) Am. Photographic Publishing Co., Boston Mass.

Mees, Charles Edward Kenneth. Photography. 227 pp. Macmillan Co., New York.

Mertle, Joseph S. Process Photography and Plate Making. A Practical Manual for the Graphic Arts. 147 pp. G. Cramer Dry Plate Co., St. Louis, Mo.

Wall, Edward John. The History of Three-Color Photography. 747 pp. (Out of Print.) American Photographic Publishing Co., Boston Mass.

Wall, Edward John. Practical Three-Color Photography. (Out of Print.) 248 pp. American Photographic Publishing Co., Boston, Mass.

Wright, G. B. Three-Color Separation Photography. Published by Author, at South Norwalk, Conn.

GLOSSARY

OF SOME TERMS USED BY PHOTOENGRAVERS, WITH THEIR DEFINITIONS AND SYNONYMS

Bath. — The silver solution, or etching solution.

Bite. — A single period of etching a metal plate.

Block. — An engraved plate when mounted type high.

Burning-in. — Heating the enamel coating on a metal plate until it carbonizes and becomes acid resistant.

Copy. — Any subject, whether drawing, painting or object submitted for photo-mechanical reproduction. An original.

Copy-board. — The board to which copy is affixed for photographing.

Copy-holder. — A sheet of glass framed, with a back-board, between which and the glass, copy can be held flat while photographing.

Cotton. — An abbreviation for gun-cotton. Pyroxylin.

Crop. — When marked on copy it means that the plate is to be cut off at the line marked near the word " crop."

Cutting. — Reducing the size of the dots in a halftone negative with chemicals. Also applied to the solution so used.

Diaphragm. — Called " stop " by engravers. Used in a lens to increase the sharpness of the image.

Dip. — Each intensification of a negative is a " dip."

Dipper. — The holder for lowering and raising the collodionized glass plate in the silver bath.

Duograph. — Two halftones made from the same copy at different screen angles and etched differently.

Enamel. — The coating on a metal plate which on being carbonized by heat becomes a strong acid resistant.

Etching. — Engraving by acid corrosion. The engraving thus made.

Etching Bath. — The acid solution used to produce an etching.

Etching Brush. — A brush used to keep the metal clean during etching.

Etching Ink. — Ink made to resist acid.

Etching Machine. — Mechanically operated device for etching printing plates.

Etching Powder. — An acid-resisting powder. Usually a resin, or powdered dragon's blood.

Etching Tub. — A shallow acid-proof box in which the etching bath flows back and forth while the box is rocked over the metal plate being etched. Abbreviated to "tub."

Exposure. — The act of submitting a sensitized surface to the action of light. Also the time occupied in the act.

Film. — Any thin skin of albumen, collodion, gelatin, fish glue, or other substances. Usually formed by the evaporation of the solvent.

Fish Glue. — The glue derived from fishes used in making the enamel acid-resist.

Flashing. — In halftone making, exposing with small stop to white paper.

Flat. — The glass on which several negative films are laid close together. The etched plate is also called a flat.

Flatness of Field. — A quality in a lens most desirable for photographing flat copy.

Focal Length. — Approximate distance of a lens from the groundglass when a most distant object is in focus. Also called the "focus" of a lens.

Focus. — When the image on the groundglass of a camera is as sharply defined as possible it is said to be "in focus."

Four-way Powdering. — Brushing powdered resin in four different directions successively over a metal plate to protect the raised parts during etching.

Grain. — A granular appearance either in a negative or on a metal plate.

Graver. — A metal tool used in engraving.

Halftone. — A printing plate made through a halftone screen. A print from such a plate.

Halftone Screen. — A transparent medium on which are parallel opaque lines single or crossed. Used in photoengraving to break up the shades of an image into dots and lines.

Highlight. — The brightest parts of a picture, hence the densest parts of a negative.

Highlight Halftone. — A halftone print in which the highest lights are entirely white, without dots.

Highlight Stop. — The largest stop used in halftone negative making.

Image. — The picture on the groundglass of a camera, on the negative, or on the metal.

Iris Diaphragms. — Lens stops formed and named after the iris of the eye. They are fixed in the lens and give only circular apertures.

Lens. — That first used by photoengravers was corrected for chromatic and spherical aberrations and was called aplanatic. Modern lenses are far more highly corrected and are called anastigmatic or apochromatic.

Magnifier. — Called a "Linen Tester." It folds up when not in use.

Mordant. — Any corrosive liquid that can be used to etch metal.

Negative. — When the lights in a subject are shown dark and the darks light. The opposite of "positive."

Normal Stop. — The diaphragm used to photograph the halftones of the copy in halftone negative making.

Panchromatic. — Sensitive to all colors.

Plate. — Term given to a sheet of glass or metal used in photoengraving.

Plate-holder. — The light-tight case that holds the sensitive plate for exposure in the camera.

Plate Pliers. — The wide-nosed pliers used to hold the metal plate while heating it.

Positive. — The image on metal. A photographic print from a negative. The opposite of negative.

Powder. — Term applied to the finely ground resin used to resist acid.

Powder-box. — The shallow box in which the powdered resin is kept, and in which the metal plate receives its powder coating.

Powdering Brush. — The broad, thick camel's hair brush used to press etching powder against the sides of the lines and sweep the rest of the bared metal free from the powder.

Print. — The positive image produced in a printing frame from a negative.

Process Camera. — The camera used by photoengravers, the lens being called a " process lens."

Process Work. — Photoengraving. Generic term given to all the photo-mechanical processes.

Rack. — A stand for holding negatives or metal plates upright.

Reducing. — Making smaller. The " cutting " solution used to make smaller dots in halftone negatives.

Reproduction. — The act of duplicating by photoengraving. A print made by photoengraving.

Rolling-up. — Covering a sensitized surface with ink after photo-printing, prior to development or between the etching operations.

Router. — Machine with a cutter revolving at high speed for removing metal not wanted in an engraving.

Screen. — The halftone screen.

Screen Distance. — Space between screen and sensitive plate.

Screen Pitch. — The number of lines to the inch or centimeter ruled on a screen.

Screeny Negative. — One in which the screen lines are too prominent.

Scum. — Transparent film of glue between the dots on a metal plate which prevents etching.

Sensitizing. — The act of making anything sensitive to light.

Shadow Stop. — The smallest stop used in halftone negative making.

Shoot-board. — A plane and bed used to square the sides of a printing block.

Shoulder. — A ledge of metal left at the side of a line or dot when etching.

Staging. — Stopping out areas of a metal plate between etchings.

Still Etching. — Etching without movement of the etching fluid.

Stop. — Photoengravers' term for lens diaphragm.

Top. — Photoengravers' term for the acid-resist on a metal plate.

Topping Powder. — The first etching powder applied to the ink image.

Undercut. — When the etching fluid has corroded the edges beneath the printing surface.

Vignette. — A halftone engraving which shades off to nothing.

Waterhouse Stops. — Diaphragms that slide into a lens slot.

Wet Collodion. — Name given to the collodion negative process because the sensitive plate is exposed in the camera while wet.

Wet Plate. — Plate made by wet collodion process to distinguish it from a dry plate.

Whirler. — Machine for revolving a metal plate so as to give an even coating.

Zinc Etching. — The act of engraving on zinc with etching fluids. A relief printing plate thus made.

Zinc Hook. — A steel cutting tool for dividing zinc or copper sheets.

Zincograph. — A photoengraving on zinc. In England called "zinco."

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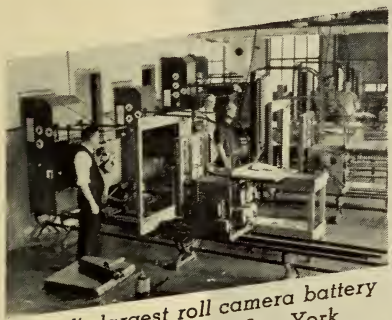

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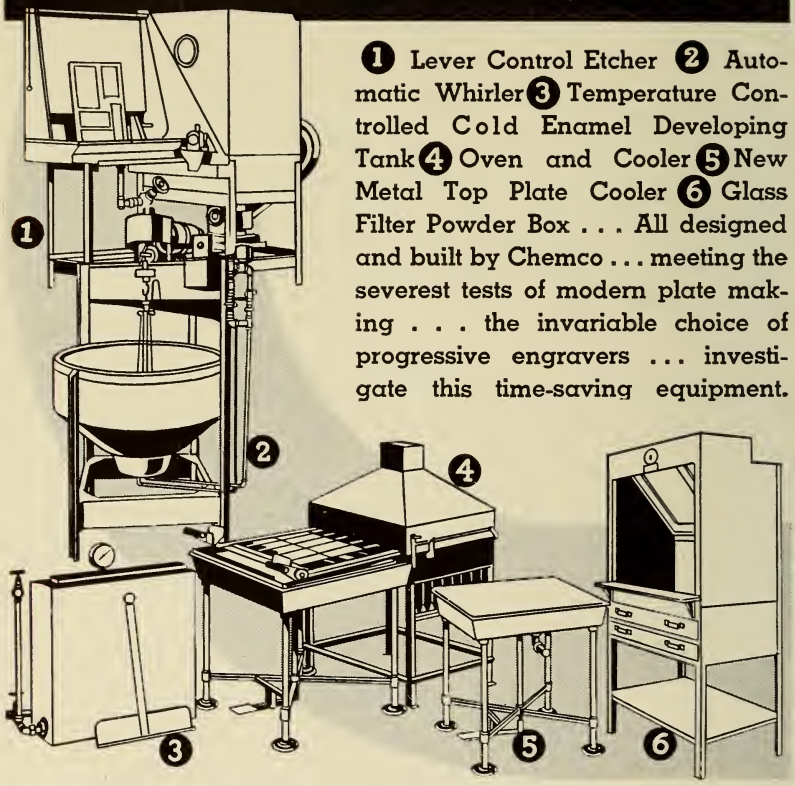

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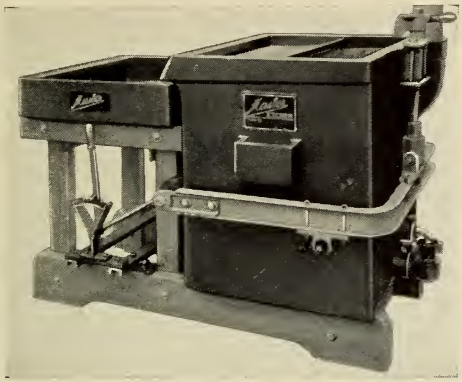

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